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CONCORD INSTRUMENT
DIVISION

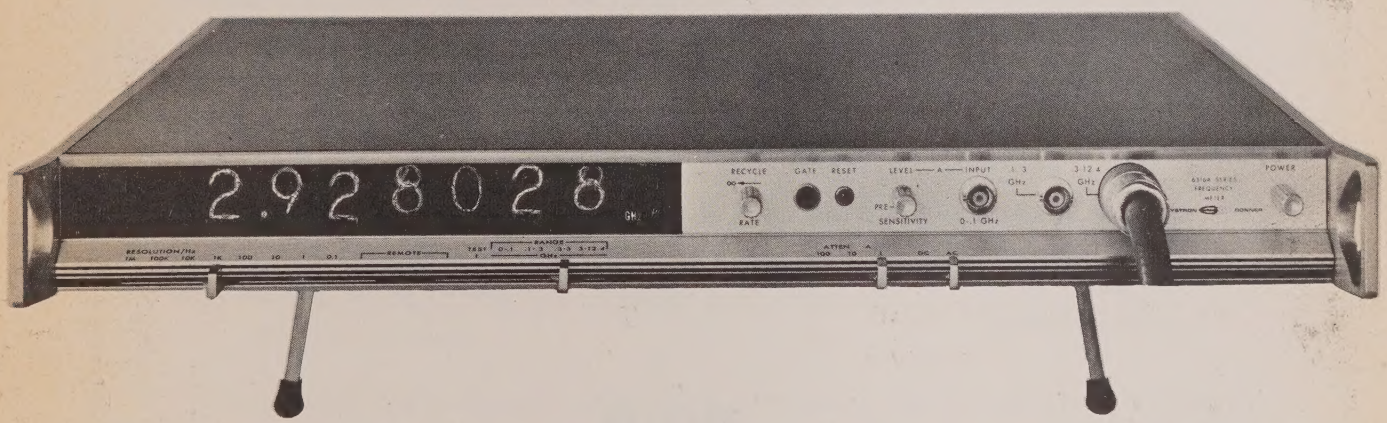
MODEL 6316A

FREQUENCY METER

SYSTRON DONNER

Concord Instrument Division

INSTRUCTION MANUAL



CONCORD INSTRUMENT
DIVISION

MODEL 6316A

FREQUENCY METER

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SYSTRON DONNER
CORPORATION

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ADDENDUM

MODEL 6316A

Delete the calibration procedures, Paragraphs 5.4.3 and 5.4.4 of Chapter 5, and add the following:

STEP 5.4.3 100 MHz Input Amplifier - P/N 33262

A) Place the range switch in the "0-.1 GHz" range and the level control to PRESET. Connect lug 10 to ground.

B) With the Dvm monitor the drains of Q9 and Q12 at R17 and R18 respectively. Adjust R27 for equal voltage (±5 MV) at these points (approximately -6.2V). (NOTE: Step B is a preliminary adjustment only.)

C) Adjust R50 for zero volts at lug 9 (±5 MV). Remove the ground from lug 10 and adjust R27 for zero volts (±5 MV) at lug 9.

D) Check the drains of Q9 and Q12 to make sure that they are still equal. If not, repeat alignment procedure. (NOTE: R34 and associated circuitry are not used in the 6316.)

STEP 5.4.4 100 MHz Amplifier and Decade - P/N 33288

A) With range switch in "0-.1 GHz" and the level control in PRESET, the voltage at the junction of S1, S2, and S3 should be zero. If not, align the input amplifier.

B) Place the range switch to TEST and adjust R2 for zero volts at S1, S2, S3 junction.

C) Monitor the collector of Q1 with DVM and adjust R5 for +1.5V (±5 MV).

D) Place range switch to "0-.1 GHz" and apply 100 MHz at 100 MV to "0-.1 GHz" input connector. With sampling 0-scope (or 100 MHz 0-scope), observe the junction of S1, S2, S3 for waveform #1.

E) Observe the collector of Q1 for waveform #2.

F) Observe Q5 emitter for waveform #3. (A slight adjustment of R5 may be necessary.)

G) Observe Q7 collector and adjust R23 for waveform #4.

H) Observe Q13 emitter for waveform #5 (Binary should be dividing by two.)

I) Observe Q13 collector for waveform #6. If necessary, adjust the value of R53 so that the positive peak is within 400 MV of ground. Recheck step G if R53 is changed.

J) Observe lug 2 for a 10 MHz ≈4V signal.

K) Remove all test equipment and observe correct readout display. Gradually decrease input amplitude from generator and adjust R5 for best sensitivity (generally 70 MV).

L) Remove the input, turn the storage switch off, and put the resolution switch in REMOTE making sure that the gate lamp remains on. Rotate the level control back and forth and watch the first indicator sequence one count each time. If there is any discrepancy, repeat the alignment procedure.

When the resolution switch is in the 10Hz, 1Hz, or the 0.1Hz position the period of time required for each measurement may be excessively long.

When measuring 10GHz, for example, with the resolution switch in the 1.0Hz position the measurement time will be more than 1.6 minutes. Because of the digital logic in the "N" computer the first reading after turning power on or changing the resolution switch to this position may take even longer.

SYSTRON DONNER CORPORATION

ADDENDUM

MODEL 6316A

Modify the following sections on Pages 5-4 and 5-5 to Read:

to the .1-.3 GHz input connector and set for 310 MHz at 150 mV rms. On the 300 MHz Prescaler board:

✓ Turn R21 to midrange, and R59 fully ccw.

✓ Return R59 slowly cw until instrument reads correctly.

✓ Reduce amplitude of generator signal gradually while adjusting R21 for maximum signal.

✓ Tune the signal generator over the full .1 to .3 GHz ranges with signal level at greater than 1V rms. If readings are erratic, readjust R59 ccw to correct.

Readings should be correct over the full range at signal levels between 100 mV and 2V.

5.4.6 .3-3 GHz and 3-12.4 GHz ACTO Ranges (Remove ACTO assembly cover, reinstall center cover screw). N Computer Test

a) Place RANGE switch in TEST position and the RESOLUTION switch in the 1k position. Remove the green wire from Terminal 13 and ground TP1 on the ACTO assembly. Verify a readout of 000.257000 GHz.

b) Ground TP4 (on 6316 only, also ground Terminals 15 & 16). Jumper the +5V buss line to TP6. Place RESOLUTION switch to 100k. Place RANGE switch to "Test". With scope, check IC1-12 for inverse signal seen at Terminal 14.

c) IC1 thru IC8 are J-K flop-flops which divide by two. Check Pin 8 of IC1 thru IC8 for 1/2 frequency seen at previous stage. (Signals should be 0 to +4V). Any discrepancies will be caused by the flip-flop or its associated gates.

d) Connect the oscilloscope (Items #2 & 3) to TP3 on the ACTO assembly. Verify a positive 4 msec gate occurs once every counter recycle.

e) Replace the wire on Terminal 13. Verify normal counter operation, 1 MHz Amplifier Adjustment.

f) Connect the oscilloscope (Items 2 & 3) to the collector of Q9 (of junction of C135/L31). Adjust C58 for maximum amplitude of the 1 MHz signal. (4V p-p).

g) Check for presence of the 1 MHz signal at the collectors of Q7 (2-3V p-p) and Q8 (3-4V p-p).
ACTO LOCAL OSCILLATOR ADJUSTMENTS

h) Place the RANGE switch in the 3-12.4 GHz position, and the RESOLUTION switch in the 1M position. Ground TP1 and TP2 on the ACTO assembly.

i) The counter will display the frequency of the high range (3-12.4 GHz) ACTO oscillator, multiplied by 257. Adjust L17 until the counter reads 000024.350 ±.01 GHz.

j) Change the RANGE switch to the .3-3 GHz position, and ground TP1 and TP2 on the ACTO assembly.

k) The counter will display the frequency of the low range (.3-3 GHz) ACTO oscillator, multiplied by 257. Adjust L14 until the counter reads 000007.335 ±.01 GHz.

l) Remove the ground connections to TP1 and TP2. 1 kHz Amplifier and Phase Shift Network.

m) Connect the oscilloscope (Items 2 & 3) to the collector of Q27. Verify a 1 kHz sinewave 1.75V ±0.25V p-p (If incorrect, change R88 to appropriate value).

n) Connect the oscilloscope external trigger to TP8 on the Frequency Function assembly.

o) Using dual trace, monitor the 1 kHz signals on the positive ends of C93 and C94. Verify approximately equal ac & dc level, and 90° phase difference. Repeat at C92 & C95.

p) Place RANGE switch in the 3-12.4 GHz position connect TP2 to the oscilloscope (Items 2 & 3) horizontal input, and ACTO assembly Terminal 1 to the vertical input (use short ground connection at the probe end). Adjust T9 for maximum amplitude and flatness of trace.

q) Place RANGE switch in the .3-3 GHz position, adjust T8 for maximum amplitude and flatness to trace.

r) Place the RANGE switch in the 3-12.4 GHz position, and the RESOLUTION switch to 1k. Rotate the LEVEL/SENSITIVITY control maximum ccw.

s) Connect a signal generator (Item 5 to the 3-12.4 GHz input and set to 10.0 GHz at -7 dBm (100 mV rms). Connect the oscilloscope vertical input to TP1 on the ACTO assembly, and external trigger to TP8 on the Frequency Function assembly.

t) Slowly rotate the LEVEL/SENSITIVITY control cw until LOK light comes on to indicate that the ACTO has locked on the input signal. Observe "1 kHz x N" signal on the oscilloscope. Adjust C112 for minimum phase modulation.

u) Rotate the LEVEL/SENSITIVITY control ccw. Remove 10 GHz signal generator input and replace with 300 MHz signal from Item 4 signal generator, at -7 dBm (100 mV rms).

v) Turn LEVEL/SENSITIVITY control cw until ACTO locks on to input signal (LOK light on). Observe the "1 kHz x N" signal on the oscilloscope. Adjust C100 for minimum phase modulation.

w) Replace signal generator with Item 5. Tune slowly from 10.0 GHz to 12.4 GHz at -7 dBm. Varify that the ACTO tracks the input correctly.

5.4.7 Remove all test leads and replace ACTO cover. Place the RANGE switch to TEST and the RECYCLE switch to ∞. Push RESET button and observe that the counter recycles.

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ADDENDUM

When the resolution switch is in the 10Hz, 1Hz, or the 0.1Hz position the period of time required for each measurement may be excessively long.

When measuring 10GHz, for example, with the resolution switch in the 1.0Hz position the measurement time will be more than 1.6 minutes. Because of the digital logic in the "N" computer the first reading after turning power on or changing the resolution switch to this position may take even longer.

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CHAPTER 1

GENERAL DESCRIPTION

1.1 INTRODUCTION

The Systron-Donner Model 6316A Frequency Meter is an ultra compact instrument for precise frequency measurements from DC into the microwave portions of the spectrum. It incorporates simple controls and a readily accessible layout for easy operation and maintenance. Its circuitry makes wide use of integrated circuits and other proven solid state devices for maximum reliability and compactness. The Model 6313A, carefully designed to satisfy the most exacting requirements, provides:

- o A fully automatic measuring technique.
- o Direct readout with counter accuracy.
- o DC to 12.4 GHz - complete uninterrupted coverage of the RF spectrum into the microwave region.
- o Easy read storage type display.
- o Nine-digit answers with automatic decimal and units-of-measure indications.
- o Complete self contained operation.

1.2 FUNCTIONAL DESCRIPTION

The Model 6316A Frequency Meter is capable of direct measurements from DC to 12.4 GHz with resolution to 0.1 Hz using three measuring modes:

- + Direct Counting in the 0.0 to 0.1 GHz range,
- + Prescaler Counting in the 0.1 to 0.3 GHz range, and
- + ACTO counting in the 0.3 to 12.4 GHz range.

The accuracy of all measurements is ±1 count ± time base stability. Resolution is selectable in decade steps from 0.1 Hz to 1 MHz by front panel switch. Most front panel controls are slide switches to save space, and to make possible the instrument's 1 3/4" panel height. Retractable legs allow bench top use. The Model 6316A may also be installed in a standard 19" rack or console.

1.3 SPECIFICATIONS

1.3.1 Direct Count Range, (0-.1 GHz A-Input)

Range:
0 to .1 GHz (DC input) 10 Hz to .1 GHz (AC input)

Resolution:
0.1 Hz to 1 MHz in decade steps

Accuracy:
±1 count ± time base accuracy

Sensitivity:
100 mV rms

Coupling:
AC or DC, switch selectable

Attenuation:
Step attenuator with factors of 1, 10, and 100

Level:
±1 volt time attenuation factor A "preset" position centers trigger level at 0 volt.

Impedance:
1 MΩ, approximately 15 pf shunt

Overload without damage:
75 V peak on x1, 200V peak on x10, and 600V peak on x100 attenuator settings

Reads in:
kHz, MHz, and GHz with positioned decimal point

Self Check:
Counts 1 MHz for resolution selected

1.3.2 Pre-Scaler Range (.1-.3 GHz Input)

Type of Input

Range:
0.1 to 0.3 GHz

Resolution:
0.1 Hz to 1 MHz in decade steps

Accuracy:
±1 count ± time base accuracy

Sensitivity:
100 mV rms

Coupling:
AC only

Impedance:
50Ω nominal

Overload without damage:
2V rms

Reads in:
kHz, MHz, and GHz with positioned decimal point

1.3.3 ACTO Range (.3-12.4 GHz Input)

Type of Input

Signals:
CW

Range:
.3 to 3 GHz and 3-12.4 GHz

Resolution:
0.1 Hz to 1 MHz in decade steps

Accuracy:
±1 count ± time base accuracy

Sensitivity:
100 mV rms

Impedance:
50Ω nominal

Maximum useable signal level:
+7 dBm

Overload without damage:
3V rms

FM Tolerance:
Maximum of 0.1% FM (FM = 60 Hz) decreasing by a factor of 2 per octave of FM above 60 Hz

Maximum AM Modulation (400 Hz to 1 kHz):
70%

Lock-on Range:
Approximately 2% of input frequency

Sweep Rate (Within any Lock-on Range):
12% f_1/sec (f_1 - instantaneous input frequency)

Reads in:
kHz, MHz, and GHz with positioned decimal point. "LOK" annunciator provides visual indication of phase-lock and correct display.

1.3.4 Time Base

Frequency Internal:
1 MHz

Stability:
Better than two parts in 10^8 per day after 72 hours warmup

Output frequencies (rear panel):
1 MHz, 3 volts peak-to-peak minimum output impedance 1,000Ω nominal 0.1 Hz to 1 MHz in decade stesp selected by RESOLUTION switch, 470Ω output impedance, 3 volts peak-to-peak minimum. Stability of outputs same as internal time base.

External standard frequency:
1 MHz, 1V rms into 1,000 required at rear panel BNC connector

1.3.5 General

Display time:
0.2s to 5s independent of gate time

Operations temperature range:
-20°C to +65°C

Storage temperature:
-55°C to +85°C

Dimensions:
1 3/4" high by 17 1/2" wide x 19" deep (allow 22" depth in rack when rack mounting the instrument)

Weight:
Approximately 20 lbs net

Power:
115V or 230V ±10% (switch selectable) 50-60 Hz, 55W

1.4 OPTIONAL FEATURES

The following list briefly describes those optional features which may be included in your instrument to enhance its operation or increase its usefulness. A detailed description of available options will be found in Chapter 7.

Option B: A high stability oscillator whose aging rate after 72 hour warmup is <±1 part in 10^{10}/24 hours.

Option B3: A medium stability oscillator whose aging rate after 72 hours warmup is <±3 parts in 10^{10}/24 hours.

Option B5: A super-high stability oscillator whose aging rate after 72 hours warmup is <±5 parts in 10^{10}/24 hours.

Option D1: Rear panel 1-2-4-8 BCD digital output using positive logic where ONE = +15 ±0.5, and ZERO = .25V ±0.25V

Option D3: Rear panel 1-2-4-8 BCD digital output using positive logic where ONE = +5 ±0.5V and ZERO = 0.25V ±0.25V.

Option P: Single line remote control, through a rear panel connector, of Function and Resolution settings.

Option R1: Addition of a rear panel input connector in parallel with the front panel "A-Input" connector.

CHAPTER 2

INSTALLATION

2.1 INTRODUCTION

The Model 6316A Frequency Meter is shipped in an operating condition, and is essentially ready for use as received. This section contains unpacking, inspection, and installation information to aid you in rapidly putting the instrument to use.

2.2 RECEIVING INSPECTION

As soon as the instrument is received check the carton for evidence of damage or rough handling. If such is found, notify the carrier and your Systron-Donner Representative - open the container only in their presence.

Use care in removing the instrument from the container. Check immediately for loose or broken control knobs, bent or broken connectors, and dents or scratches on the panel surfaces. If damage of any nature is found refer to the warranty instructions.

All Systron-Donner instruments must pass rigid tests before leaving the plant. Even so, a quick test should be performed as soon as possible after unpacking the instrument, to ensure that it was not damaged in shipment. See Chapter 3.3.

2.3 INSTALLATION

2.3.1 Power

The instrument is provided with a three conductor power cord which will ground the case when connected to a 3-connector grounding outlet. If a grounding outlet is not available, an adapter must be used which provides a grounding connection. Make sure the rear panel 115-230 switch is in the correct position before connecting the instrument to a power source.

2.3.2 Cooling

The SD 6316A design incorporates a cooling fan. Cooling air enters the case through holes near the front of the bottom panel, and exhausts through a screened opening in the rear panel. Be careful not to obstruct the flow of air into or out of the case, expecially when the instrument is resting flat on its bumper flat with the tilt stand folded up or removed.

NOTE

If the instrument is to be rack or console mounted and the stand and bumper feet will interfer, remove as required.

2.4 STORAGE AND RESHIPMENT

Environmental conditions during storage and shipment should be limited as follows:

- o Maximum temperature 85°C.
- o Minimum temperature -55°C.

To protect the instrument during shipment from place to place or storage, use the best packaging methods available. Contact the nearest Systron-Donner field office for materials similar to those used in original factory packaging. Contract packaging companies can provide dependable custom packaging on short notice.

- If possible, use the original container designed for the instrument. Otherwise use a strong carton (350 lb f/in^2 bursting strength) or wooden box to house it.
- Wrap the instrument in heavy paper or plastic before placing it in the shipping container.
- Use plenty of packing material around all sides of the instrument and protect the front panel with cardboard strips.
- Seal the package with strong tape or metal bands. Mark DELICATE INSTRUMENT on outside of package.
- Refer to the warranty page of this manual and check with Systron-Donner field office for shipping instructions. In all correspondance, refer to an instrument by model number and full serial number.

CHAPTER 3

OPERATION

3.1 GENERAL

The Model 6316A measures the frequency of signals applied to any one of its three inputs within the range specified for that input. Its operation is automatic with proper selection of switch settings, and its display requires no interpretation. The following sections discuss the various controls and connectors, and describe simple operating procedures and tests. A short discussion is also included on intrinsic error and its effect on instrument operation.

3.2 CONTROLS, CONNECTORS, AND INDICATORS

3.2.1 Front Panel Description

Figure 3-1 shows the instrument's front panel, and Table 3-1 describes the functions of the elements located there.

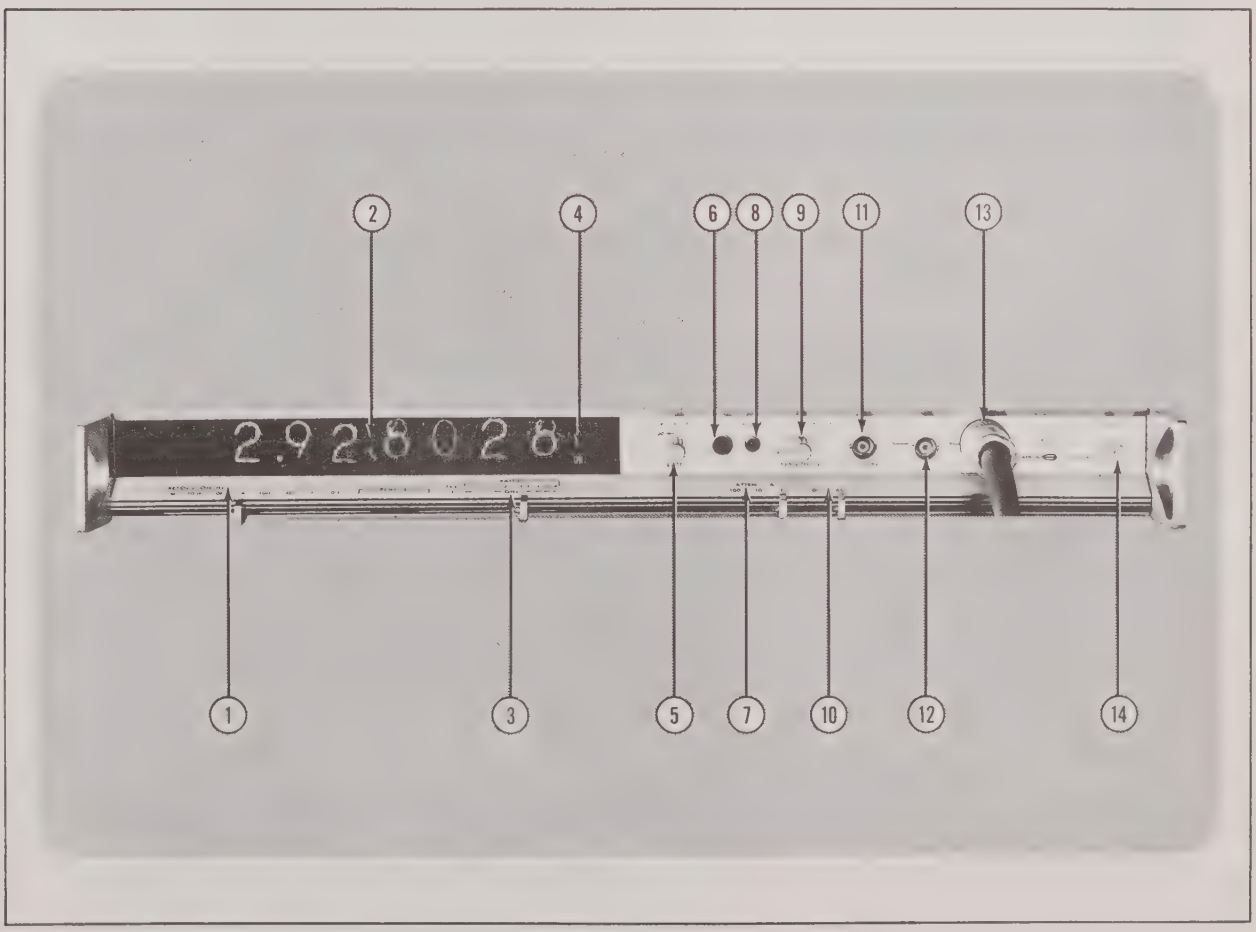


Figure 3-1. Model 6316A Front Panel

Table 3-1. Front Panel Controls - Connectors - Indicators

Index	Nomenclature	Function
1	RESOLUTION Selector switch	Selects one of the eight time-base output frequencies to be used as time reference for rate measurements. They range from 0.1 Hz to 1 MHz in decade steps corresponding to time units from 10 seconds to 1.0 microsecond. This switch also controls the automatic decimal point indication in terms of kHz, MHz, or GHz for measurement of the RATE function. REMOTE position permits remote control from rear panel connector with P Option.
2	Digital Display	9 Numerical indicator tubes for digital display of measurements made and decimal points.
3	RANGE selector switch	Selects the frequency ranges of the instrument -- 0-.1, .1-.3, 0.3-3 and 3-12.4 GHz. Selects TEST function, giving the operator the capability to self-test the instrument, using the internal 1-MHz time base. REMOTE position permits remote control from rear panel connector, with P Option.
4	Measurement Units Annunciator	Displays measurement units for data displayed, as selected by the RESOLUTION switch kHz, MHz, and GHz. Also displays the "LOK" indication of phase-lock and correct answer in the ACTO mode (.3-12.4 GHz).
5	RECYCLE/RATE control	Varies the duration of data display from approximately 0.2 second to 5 seconds between automatic reset and recycle for the next measurement. In the extreme ccw position (∞), the display is in hold until manually reset.
6	GATE indicator	Lights while count gate is open.
7	ATTEN A selector switch	Selects attenuation factor (1, 10, or 100) for A Input signals.
8	RESET pushbutton	Manual control to reset counter to zero.
9	LEVEL/SENSITIVITY control	With the RANGE selector switch in the 0-.1 GHz position, this control selects the triggering point on the input signal waveform. With the RANGE control in either the .3-3, or 3-12.4 GHz position, this control extablishes the gain of the ACTO high frequency amplifier. In the PREset position (maximum ccw), the trigger level for the A Input is set to the zero crossover point for the 0-.1 GHz range.
10	AC-DC switch	Selects direct coupled input (DC position), or a series/parallel capacitor-resistor coupling network (AC position) for the 0-.1 GHz A Input only.
11	(A) INPUT -0-.1 GHz connector	Input BNC type connector for 0-.1 GHz signals.

Table 3-1. Front Panel Controls -Connectors - Indicators (con't.)

Index	Nomenclature	Function
12	.1-.3 GHz input connector	Input BNC type connector for .1-.3 GHz signals.
13	.3-12.4 GHz input connector	Input N type connector for .3-12.4 GHZ signals.
14	POWER switch	Rotating switch turns ac power to the instrument on and off.

3.2.2 Rear Panel Description

Figure 3-2 shows the instruments rear panel, and Table 3-2 describes the function of the elements located there.

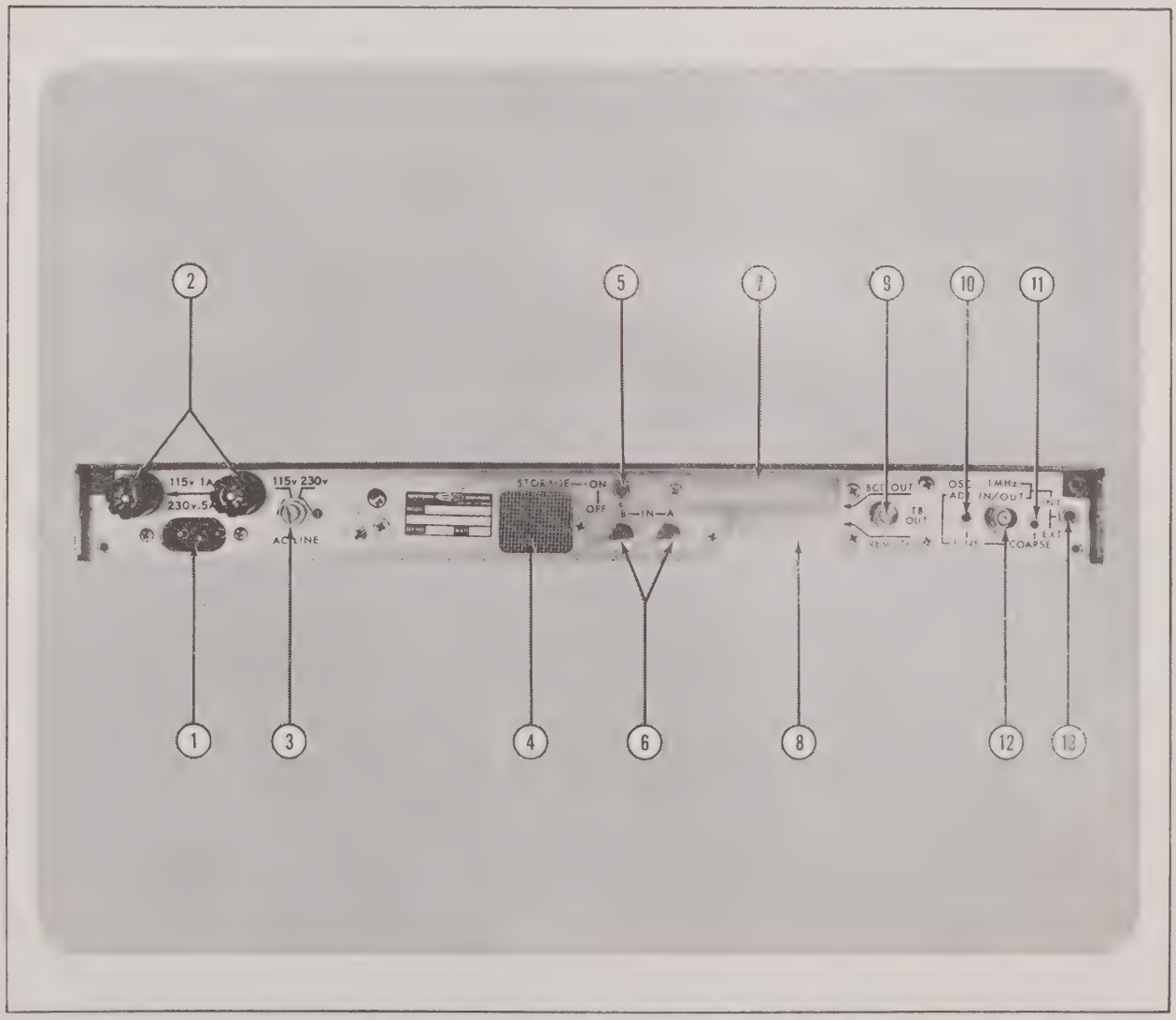


Figure 3-2. Model 6316A Rear Panel

Table 3-2. Rear Panel Controls - Connectors

Index	Nomenclature	Function
1	Input connector, ac	Recessed male safety connector for separate ac power cord.
2	FUSE holders 115V/A 230V.5A	AC input line fuses, one for each side of the line (1.0 A for 115V, 0.5A for 230V).
3	115V 230V/AC LINE selector switch	Rotary switch sets internal circuits for use with either 115V or 230V ac power sources.
4	Cooling blower outlet	Exhaust vent for blower system.
5	STORAGE ON-OFF switch	In the ON position, allow the instrument to display last naswer during next measurement. In the OFF position allows the instrument to continuously update the display during the measurement part of the cycle.
6	B-IN-A	Location of rear panel input when the "R1" Option is installed*
7	BCD OUT	Location of rear panel connector when "D" series option is installed*
8	REMOTE	Location of rear panel connector when the "P" option is installed*
9	TB OUT connector	This BNC type connector provides a time base output signal as selected by the RESOLUTION switch.
10/11	OSC ADJ FINE COARSE	Panel openings to reach adjusting controls included in certain oscillator options.*
12	1 MHz IN/OUT connector	This BNC type connector connects to the instruments internal oscillator circuit.
13	INT-EXT switch	Switches the 1 MHz IN/OUT connector between functions of input and output. In the INT position, the output of the instrument's internal time base oscillator is available at the connector (1 MHz, 3V p-p minimum). In the EXT position, the internal oscillator is disconnected and the connector provides means of connecting an external time base oscillator (10 kHz to 2 MHz, 1-10V rms).

*This rear panel assembly is common to several Systron-Donner thin-line instruments, and may contain provisions for features not found in the Model 6316A Frequency Meter.

3.3 INITIAL TURN-ON AND OPERATIONAL CHECKS

The following procedures may be used to quickly verify proper operation of the instrument following installation or long periods of non-use. Should the instrument fail any of these checks, refer to Chapter 5, MAINTENANCE AND REPAIR.

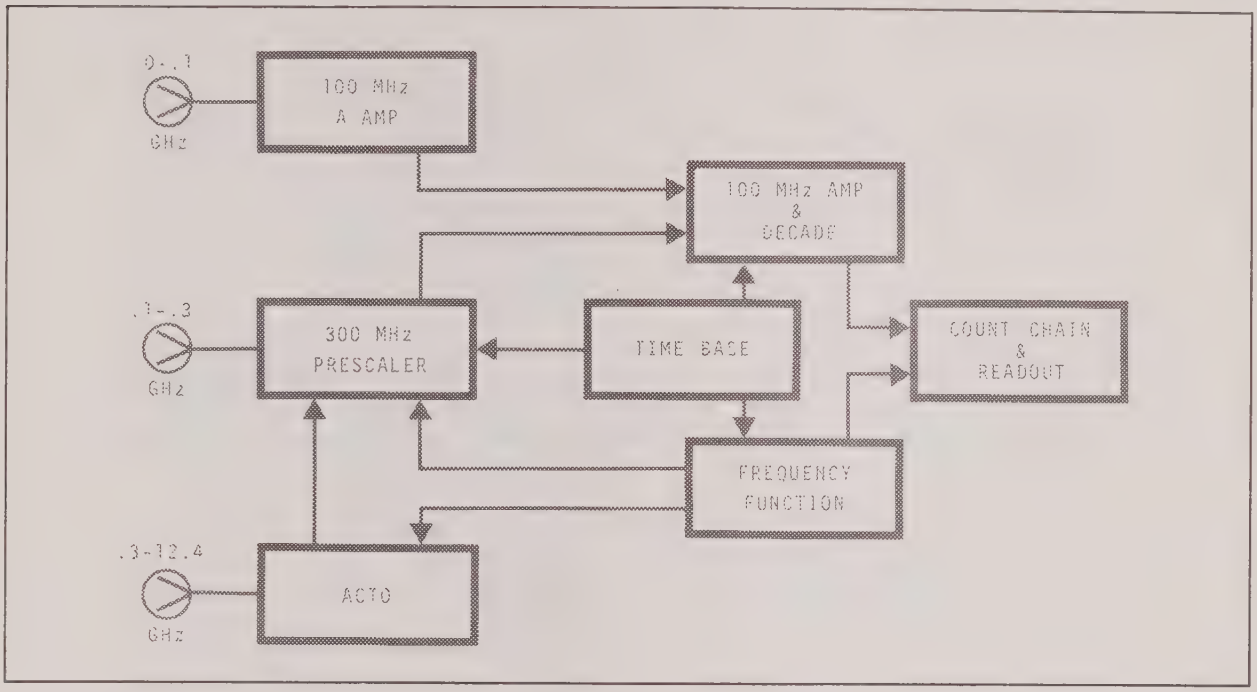


Figure 3-3. Model 6316A Block Diagram

3.3.1 Initial Functional Test

On the rear panel:

1. Connect the instrument to an appropriate power source (unless already accomplished during installation), and verify correct setting of the 115V-230V selector switch.
2. Place the STORAGE ON/OFF switch in the ON position.
3. Place the INT-EXT switch in the INT position.

On the front panel:

4. Move the RANGE switch to the TEST position.
5. Turn the RECYCLE-RATE control fully cw for minimum display time.
6. Turn the POWER switch cw to its on position.
7. Starting at the 1M psotion, move the RESOLUTION/Hz switch to each of its 9 positions and observe that the instrument displays the test readings as shown in Table 3-3.

Table 3-3. Self-Test Check Table

RESOLUTION/Hz switch position	Correct indication
1M	000000.001 GHz
100k	00000.0010 GHz
10k	0000.00100 GHz
1k	000.001000 GHz
100	00001.0000 MHz
10	0001.00000 MHz
1	001000.000 kHz
0.1	00000.0000 kHz
REMOTE	00000.0000 kHz

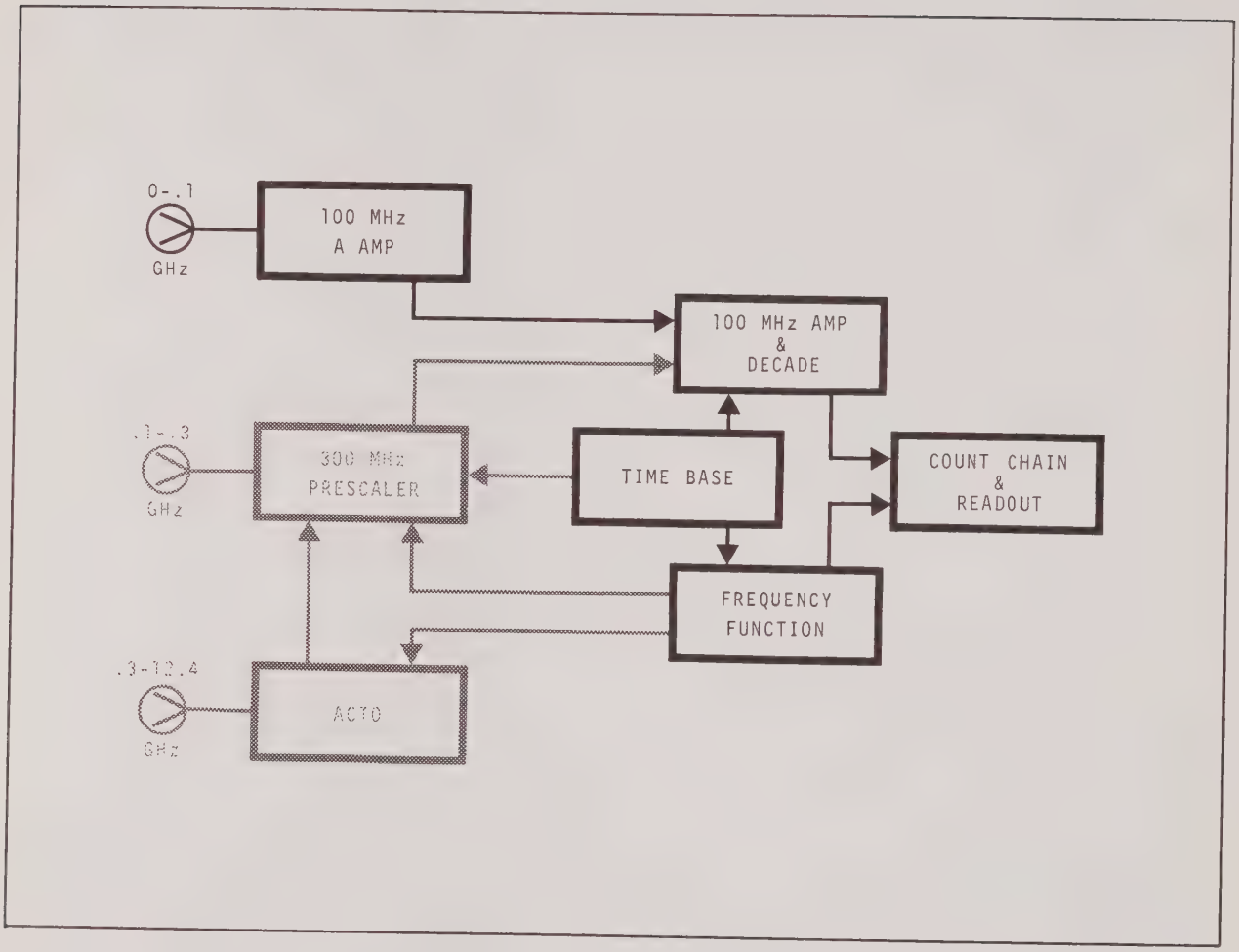


Figure 3-4. Model 6316A Block Diagram Direct Counting Mode Highlighted

On the front panel:

1. Move the RESOLUTION/Hz switch to the "10" position.
2. Move the RANGE switch to the "0-.1" position.
3. Turn the RECYCLE-RATE control fully cw for minimum display time.
4. Turn the LEVEL-SENSITIVITY control fully ccw into the PREset detent position.
5. Move the AC-DC switch to DC.
6. Move the ATTENUATION switch to 100.
7. Apply a 1-10 MHz cw signal to the 0-.1 GHz A INPUT connector. Adjust the signal level to at least 100 mV (observe signal level precautions outlined in Chapter 1.3).
8. Observe the display of a correct measurement of the applied signal.
9. If the instrument fails to display a measurement, move the ATTENUATION switch to a lower setting.
10. If the instrument fails to respond at the lowest ATTENUATOR setting, check that the level of the input signal is at least 100 mV.

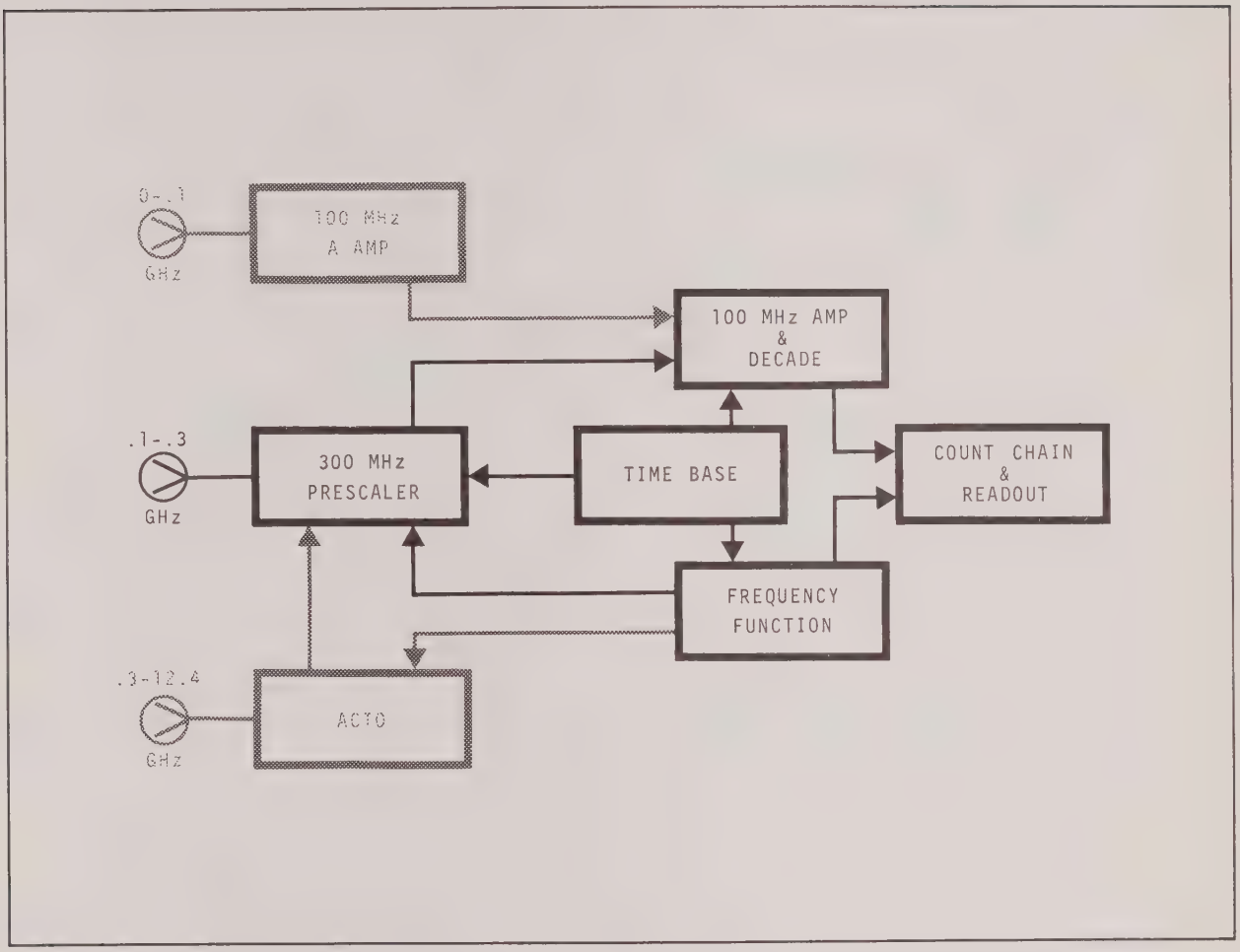


Figure 3-5. Model 6316A Block Diagram Prescaler Counting Mode Highlighted

On the front panel:

1. Move the RESOLUTION switch to the "100" position.
2. Move the RANGE switch to the ".1-.3" position.
3. Turn the RECYCLE-RATE control fully cw for minimum display time.
4. Apply a 100-300 MHz cw signal to the .1-.3 GHz input connector. Adjust the signal level to at least 100 mV (observe signal level precautions outlined in Chapter 1.3).
5. Observe the display of a correct measurement of the applied signal.
6. If the instrument fails to respond check that the level of the input signal is at least 100 mV.

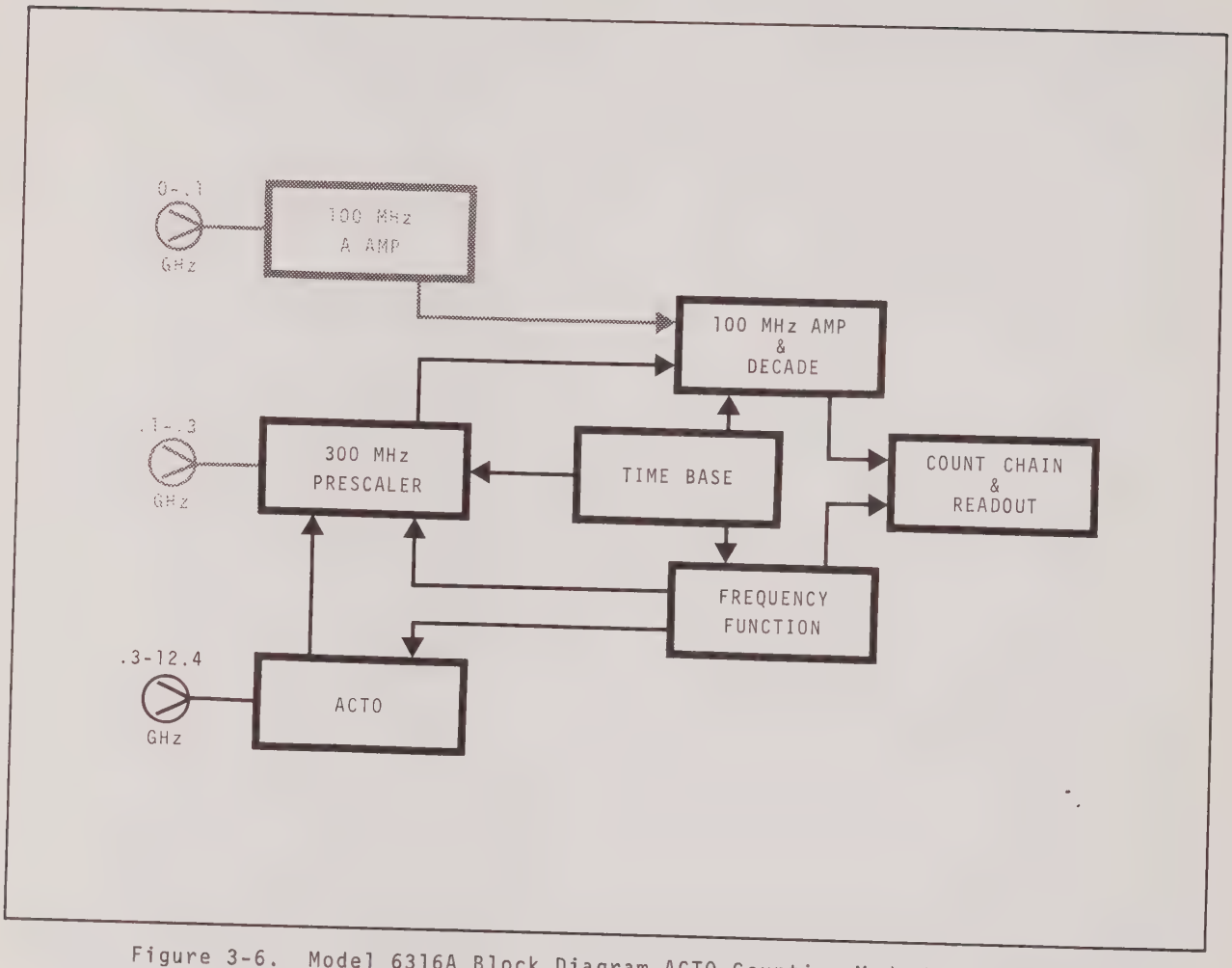


Figure 3-6. Model 6316A Block Diagram ACTO Counting Mode Highlighted

On the front panel:

1. Move the RESOLUTION/Hz switch to the "100" position.
2. Move the RANGE switch to the ".3-3" position.
3. Turn the RECYCLE-RATE control fully cw for minimum display time.
4. Turn the LEVEL-SENSITIVITY Control fully ccw, but not into the PREset detent position.
5. Apply a .3-12.4 GHz cw signal to the .3-12.4 GHz input connector. Adjust the signal level to at least 100 mV (observe signal level precautions outlined in Chapter 1.3).
6. Turn the sensitivity control cw until the "LOK" indication appears on the center annunciator panel, followed by a display of a correct measurement of the applied signal.
7. Turn the LEVEL-SENSITIVITY control ccw. Observe loss of the "LOK" indication and eventual loss of the display (all digits return to "0").
8. Slowly turn the LEVEL-SENSITIVITY control cw. Observe reaquisition of the "LOK" indicator at same point, followed by a redisplay of the correct measurement.

3.4 OPERATING PROCEDURES

Operation of the SD 6316A Frequency Meter is nearly automatic. The following items are listed only as a guide to proper operations.

- o Always set RESOLUTION/Hz switch for desired display.
- o Set RANGE switch to coincide with the frequency to be measured.
- o Set RECYCLE-RATE control to obtain desired display time.
- o Set ATTENUATION, AC-DC, and LEVEL-SENSITIVITY controls to obtain best measurements results.
- o Connect input signal to the proper input connector. Observe input signal level precautions.

3.5 APPLICATIONS

Nine Digit accuracy in seconds. The sample time is the time required for the counter to accumulate and display an answer. This sample time is calculated as follows:

$$\text{Sample Time} = \frac{\text{Harmonic}}{\text{Resolution in Hz}} =$$

Harmonic x Time Base Period

$$\text{where Harmonic} = \frac{\text{RF Input Frequency}}{\text{ACTO Local Oscillator Frequency}}$$

$$\text{Resolution} = \frac{1}{\text{Time Base Setting (seconds)}}$$

The ACTO Local Oscillator Frequencies are:

Model 6316A = 33 MHz (low range)
Model 6316A = 100 MHz (high range)

$$\text{Thus, Sample Time} = \frac{\text{Input Frequency}}{\text{ACTO Frequency}} \times$$

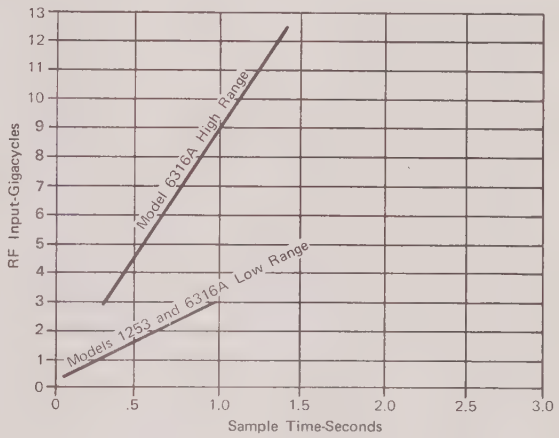
Time Base Setting.

Example: An RF input of about 8.2 GHz is applied to the Model 6316A ACTO.

$$\text{Sample Time} = \frac{8200}{100} \times \text{Time Base Setting.}$$

For 8 digit presentation (100 Hz resolution), the Time Base Switch would be set to 10^{-2}. The sample time would be about 0.8 sec, and the Accuracy of the reading is better than ± 2 parts in 10^{-8} (± 1 count, $\pm$ oscillator stability).

It is evident that the only limitation in accuracy is the ± 1 count counting error, and the stability and absolute setting of the internal crystal. The 1 part in 10^9 per day aging rate of the Systron-Donner High Stability Oscillator (Option B) assures a state-of-the-art measurement.



Measurement Time for 100 Hz Resolution Answers

3.6 OPERATING NOTES

3.6.1 Measurement Accuracies

The operational accuracy of electronic measuring instruments can be effected by any of several factors. The operator should understand them if he is to obtain the best results possible. The paragraphs which follow discuss these factors, and how to minimize their effects.

3.6.2 Oscillator Stability

The stability of the instrument's internal crystal-controlled oscillator is a significant factor effecting accuracy. Prime causes of instability are temperature variations within the oscillator circuit, fluctuations in line voltage, and aging.

Oscillator instability may be reduced to a minimum by the following techniques:

a) Leave the instrument on at all times. The aging rate of an oscillator is greatest when it is first turned on. As an example, the standard oscillator supplied with the SD Model 6316A Frequency Meter has an aging rate of 2 parts in 10^8/24 hours, after 72 hours dynamic, and 7 parts in 10^9/24 hours after 30 days dynamic.
b) Provide the instrument with a power source as free as possible from fluctuation.
c) Protect the instrument from sudden drafts or other rapid changes of temperature.
d) Have the oscillator calibrated frequently with a Frequency Standard. Periodic comparison against such a standard will enable the oscillator to be corrected for drift.

In those instances of need for measurements of extremely high accuracy, a Secondary Standard Oscillator may be connected to the rear panel 1 MHz input and used in lieu of the internal oscillator.

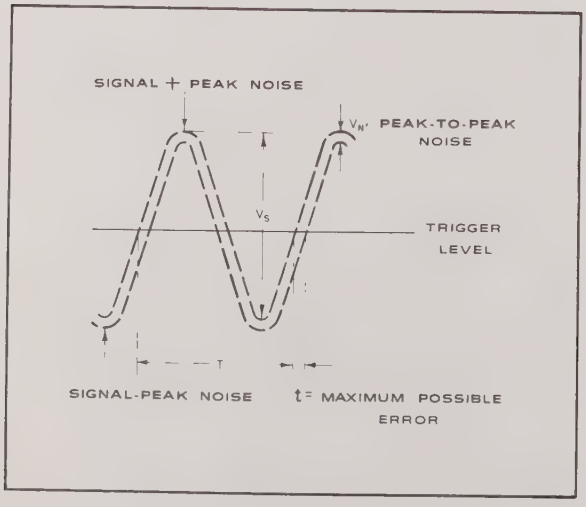


Figure 3-7. Gating Error

3.6.3 Gating Error

Gating is responsible for a possible error of ±1 count, in the least significant digit, in all types of measurements. This error is possible because the incoming signal passing through the count gate is not synchronized with the time base pulses which control the gate. As demonstrated in figure 3-7, the first or last cycle of the input signal may or may not pass through the gate to be counted, resulting in the possible error.

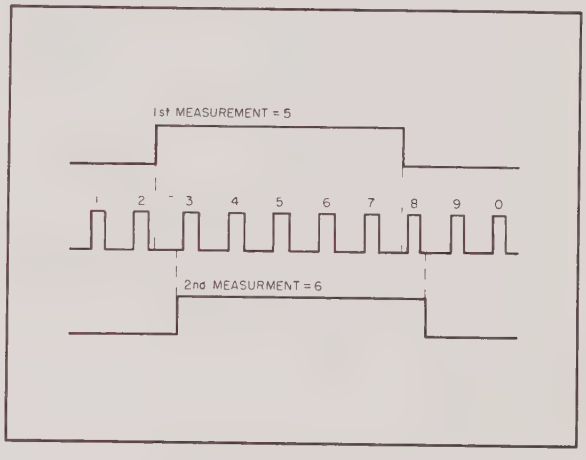


Figure 3-8. Count Error Due to Noise

3.6.4 Count Error Due to Noise

Noise superimposed on the input waveform may cause suprious count pulses to appear at the output of the amplifier and, consequently, to be counted. An output pulse occurs and is counted each time the input signal crosses and recrosses the selected trigger voltage level of the amplifier, as shown in figure 3-8. Since an input signal cycle must usually have amplitude of at least 0.2 to 0.3 volt p-p to cause triggering spurious counts can be eliminated by attenuating the total input-plus-noise signal to suitable amplitude. It is important to have both attenuator and trigger level controls set properly when measuring signals under marginal conditions of noise.

3.6.5 Loading Error

One frequently overlooked and generally not significant source of error may occur if the connection of the instrument to the external signal causes a frequency or amplitude shift of the external signal. This error will only be noticed with signal sources of relatively high impedance as compared to the input impedance of the counter.

For signals of sufficient amplitude, the loading error factor can be reduced by placing either a small coupling capacitor or a large resistor in series with the input signal. The isolating component should be located at the signal source so that it will also isolate the cable capacity.

CHAPTER 4

PRINCIPLES OF OPERATION

4.1 INTRODUCTION

The Model 6316A Frequency Meter consists of four basic elements:

+ Signal Input circuits
+ Counting and Display circuits
+ Frequency Function circuits
+ Time Base circuits

This chapter contains a detailed description of the operation of these circuits; first overall, and then section by section. Finally, a description of each Integrated Circuit (IC) used will be found at the end of chapter 5.

4.2 GENERAL THEORY

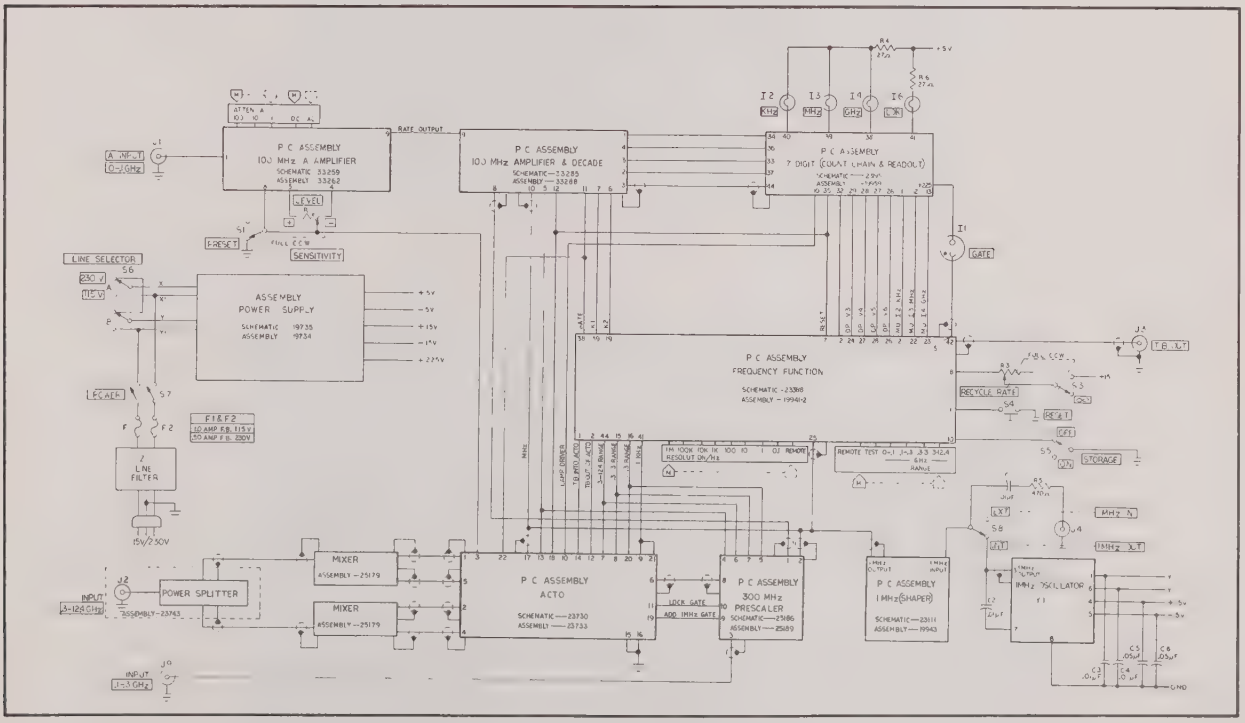


Figure 4-1. Block Diagram Model 6316A [25583]

The Model 6316A Frequency Meter accepts cw type input signals at any one of its three front panel input connectors, within the frequency range appropriate for that connector, and within the instrument's overall range of DC to 12.4 GHz. The signal is processed through the input stages, and arrives in the 100 MHz Amplifier & Decade circuit ready to be accurately gated and counted.

In the prescaler counting mode (.1-.3 GHz), the signal is processed through the 300 MHz Prescaler circuit, where it is divided-by-four by two cascaded Flip-Flops. The resultant then passes to the 100 MHz Amp & Decade circuit.

In the ACTO counting mode (.3-12.4 GHz), the signal is processed in the ACTO circuits, and a resultant representative signal is fed to the 300 MHz Prescaler assembly where it is processed before it passes to the 100 MHz Amp & Decade.

At the 100 MHz Amp & Decade circuit input, three reed relays, controlled by the front panel RANGE switch, are used to switch the input of the amplifier to the proper signal source. These are the 100 MHz A Amplifier, the 300 MHz Prescaler, or the 1 MHz Time Base signal used as the input signal in the TEST mode of operation.

The passage of the input signal is then further controlled by a count gate. The control voltage for the count gate is produced in the Frequency Function circuits. This count gate admits the input signal to the counting decades for a precise length of time during each counting cycle (from recycle rate control). The counting decades count the total number of signal pulses admitted by the count gate during the time the gate is open, and convert this count to a BCD logic output. The Count Chain and Readout circuit receives the BCD logic into its count chain

Upon receiving a transfer pulse from the Frequency Function circuits at the end of the count period, the information in the count chain is transfered to the storage binaries where it is immediately available to the readout circuits as a stored BCD representation of the count totalized by the counting decades. These readout circuits decode the BCD information and activate the representative digital display.

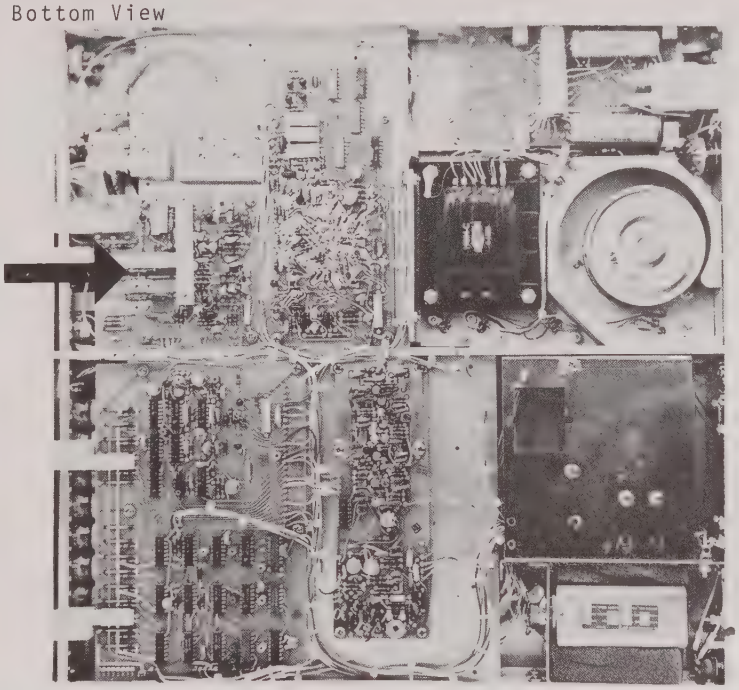
The frequency Function circuit board supports a series of magnetic reed switches whose operations are controlled by magnets mounted on the front panel RESOLUTION/Hz and RANGE switch arms. These switches provide selectable ground conditions for the NAND and NOR logic circuits which, along with time base pulses, provide the logic and precise timing needed for instrument operation.

A stable internal crystal oscillator produces the basic 1 MHz signal used for timing throughout the instrument. The standard unit provides an accuracy of ± 7 parts error in $10^9/24$ hours after specified warm-up. Optional oscillators, available at extra cost, can increase this accuracy to ± 5 parts error in $10^{11}/24$ hours after warm-up. An external oscillator, such as a Frequency Standard, may also be used when greater accuracy is required.

4.3 CIRCUIT DESCRIPTIONS

4.3.1 100 MHz A & B Amplifier (Schematic #33259, Ass'y #33262)

Model 6316A Bottom View



100 MHz A Amplifier

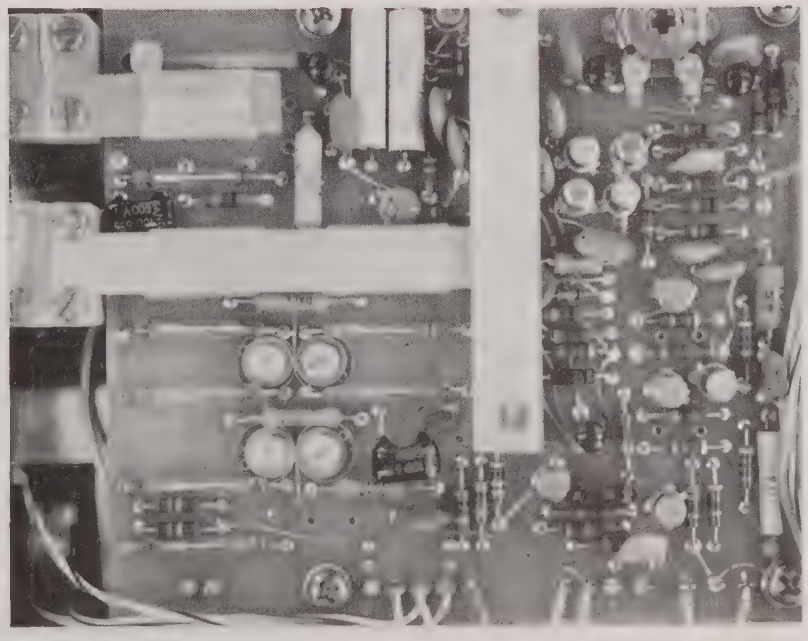


Figure 4-2. 100 MHz A Amplifier, Location

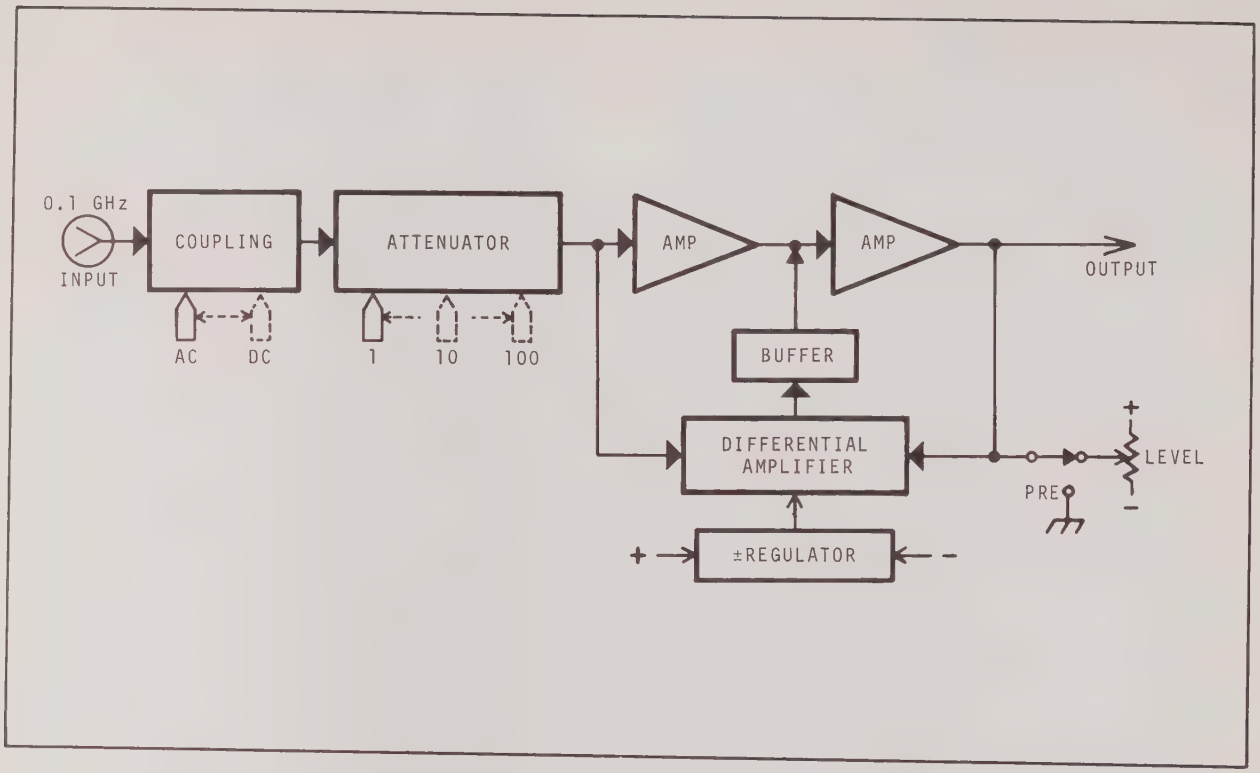


Figure 4-3. 100 MHz A & B Amplifier, Block Diagram

NOTE

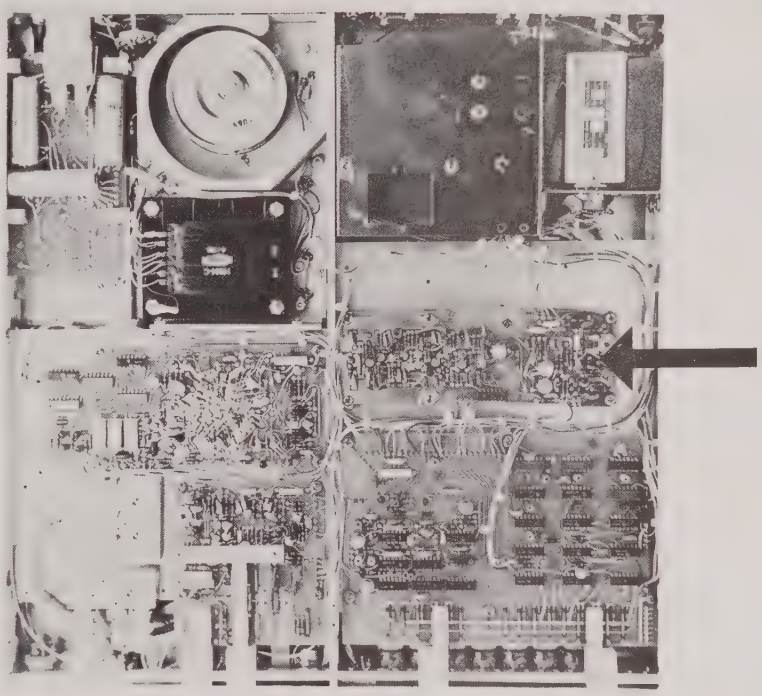
This PC assembly is common to several Systron-Donner instruments. Not all of the circuits present are used in this instrument.

This circuit is basically an impedance changing network. It has a voltage gain of approximately 0.7, but a very high current gain. It displays a 1 megohm impedance at the input of push-pull FET's Q1 and Q4, and a 50 ohm impedance at the output at pin 9. It features dc level stability, and speed at high frequencies.

Incoming signals are fed from the 0-.1 GHz front panel input connector, through the AC-DC coupling network, through the 1-10-100 ATTENuation network, to the push-pull amplifier Q1/Q4. The output of this stage is coupled to complimentary emitter followers Q2/Q5-Q3/Q4, along with the output of the differential amplifier through buffer Q7. The output of the emitter followers, which is the output of this circuit, is fed back to one side of the differential amplifier at the gate of Q12. Along with the output of the trigger level circuit. The input signal is tied to the opposite side of the differential amplifier at the gate of Q9. This circuit compares the dc level of the output which must remain constant with that of the input, and inserts ± offset voltages to compensate for high and low input levels. The PRESET trigger function clamps the output to near the 0 level. Transistors Q10 and Q11 and their circuits act as dynamic power supply regulators and filters for the differential amplifier circuits.

4.3.2 300 MHz Prescaler (Schematic #25186, Ass'y #25189)

Model 6316A Bottom View



300 MHz Prescaler Assembly

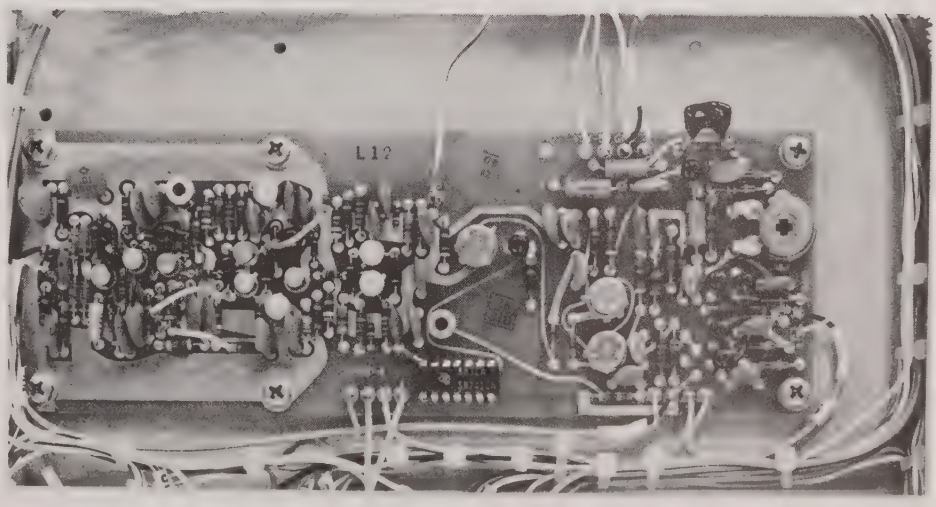


Figure 4-4. 300 MHz Prescaler, Location

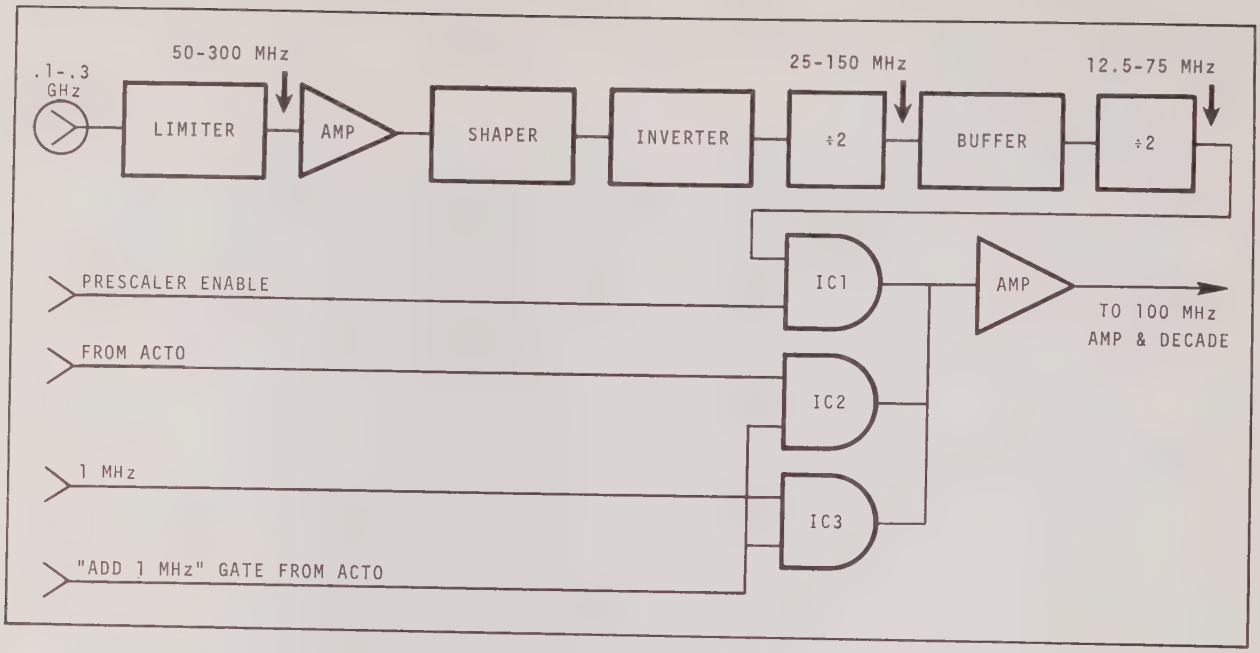


Figure 4-5. 300 MHz Prescaler, Block Diagram

As seen in the block diagram, the 300 MHz Prescaler circuit is simple and straight forward. It divides by four any frequency between 50 and 300 MHz applied to its input. The resultant 12.5-75 MHz output is then coupled to the next stage through an IC logic gating circuit. This gating circuit is also used in the processing of count signals from the ACTO circuits when the instrument is being used in the .3-12.4 GHz range.

The input signal, applied to pin 3, is first limited by the diode bridge CR1-2-3-4, and then applied to amplifier Q1. The collector of Q1 is coupled to the cathode of tunnel diode CR5. CR5 is biased with a load line such that it has two stable states, represented by points A and B on the curve shown in figure 4-6.

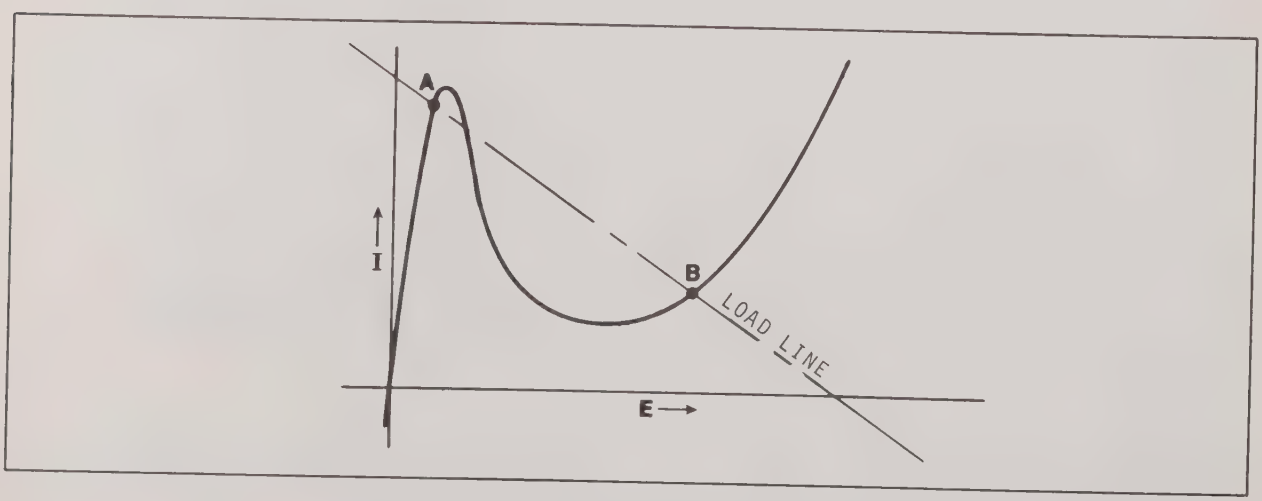


Figure 4-6. Tunnel Diode Curve

Any negative excursions of current flow will force the tunnel diode CR5 into the high voltage state at point A. Positive excursions will cause CR5 to be driven down to the low voltage state at point B.

Negative going voltages present at the cathode of CR5 will be coupled through R19 to the emitter of Q2, a grounded base amplifier. The square waves of current made available at the collector of Q2 are differentiated by inductor L3, and the resultant pulses coupled through R63 to the base of Q3. Tunnel diode CR6 sharpens the negative going pulses while damping out the positive going pulses. These negative pulses, inverted by Q3, drive the emitters of Q5 and Q6 which form the 300 MHz binary. Initially either Q5 or Q6 will be in the "on" state, and the other will be in the "off" state. A positive pulse on their common emitter line will cause a reversal of state, and can be accomplished at a rate exceeding 300 MHz.

The grounded base transistor Q17 acts as a buffer between the binary and any load, while Q16 balances its base-emitter offset voltage against the voltage generated by the base-emitter junction of Q17.

L9 differentiates the square wave output from Q17 and the 300 MHz binary.

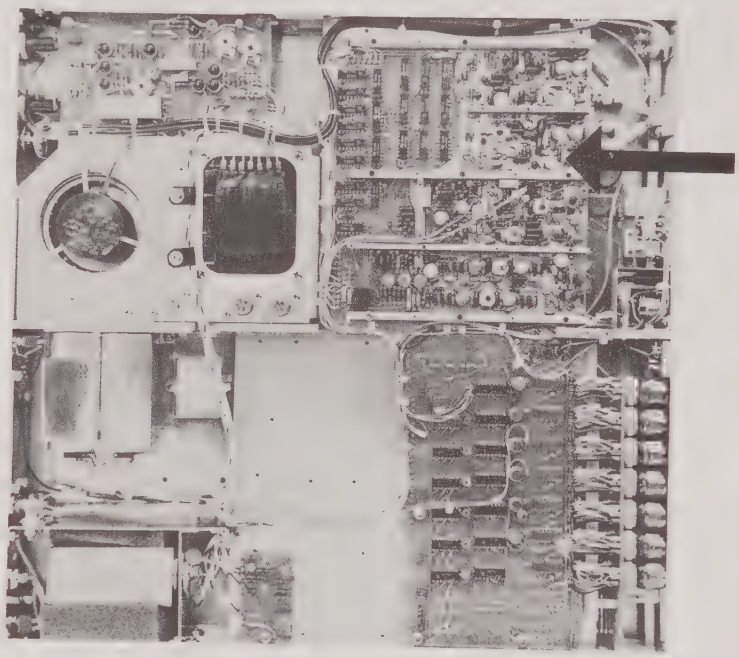
The resultant negative pulses are amplified and inverted by Q7, and then coupled to the common emitters of Q9 and Q10. Q9 and Q10 form the second binary, and can divide by two up to a maximum frequency exceeding 150 MHz. The output of this second binary is taken from the junction of R34 and R35, and is coupled through C19 to pin 2 of IC1 in the gating circuits.

When the prescaler is to be used, pin 7 of IC1 must be grounded. Placing the front panel RANGE switch in the .1-.3 GHz position supplies this ground from the Frequency Function circuits through pin 5 to the base of Q18. This ground applies voltage to the base of IC1's transistor A permitting amplification of the prescaler signal, which is then gated out through IC's pin 6 to the base of Q11. The collector of Q11 is coupled to pin 1 via the cascaded emitter followers Q12, Q13, Q14, and Q15. Removing the ground from IC1 pin 7 blocks passage of the prescaler output signal.

IC2 and IC3 process signals from the ACTO circuits, and will be discussed in that section. A discussion of each type IC will be found in Chapter 5.

4.3.3 .3-12.4 GHz ACTO (Schematic #23730, Ass'y #23733)

Model 6316A Top View



ACTO Location (Top cover plate removed)

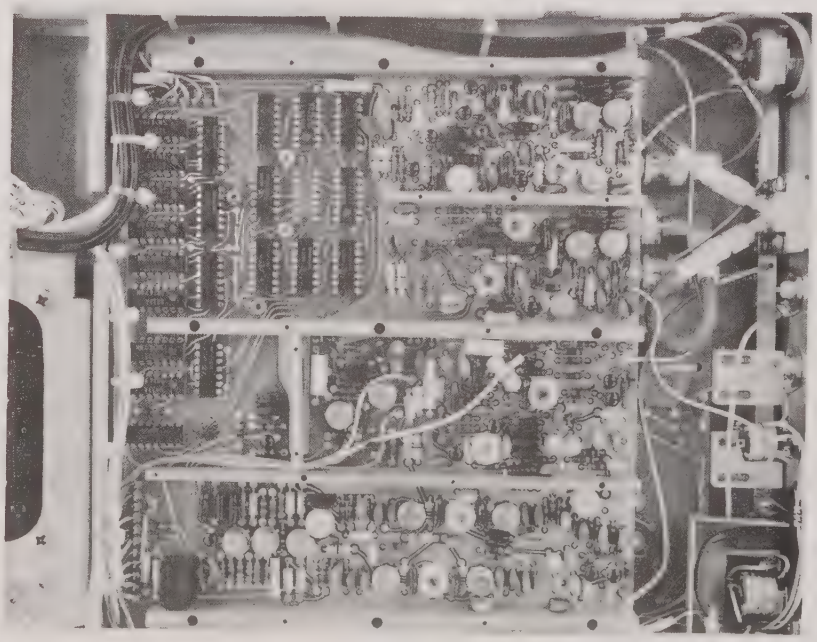


Figure 4-7. .3-12.4 GHz ACTO, Location

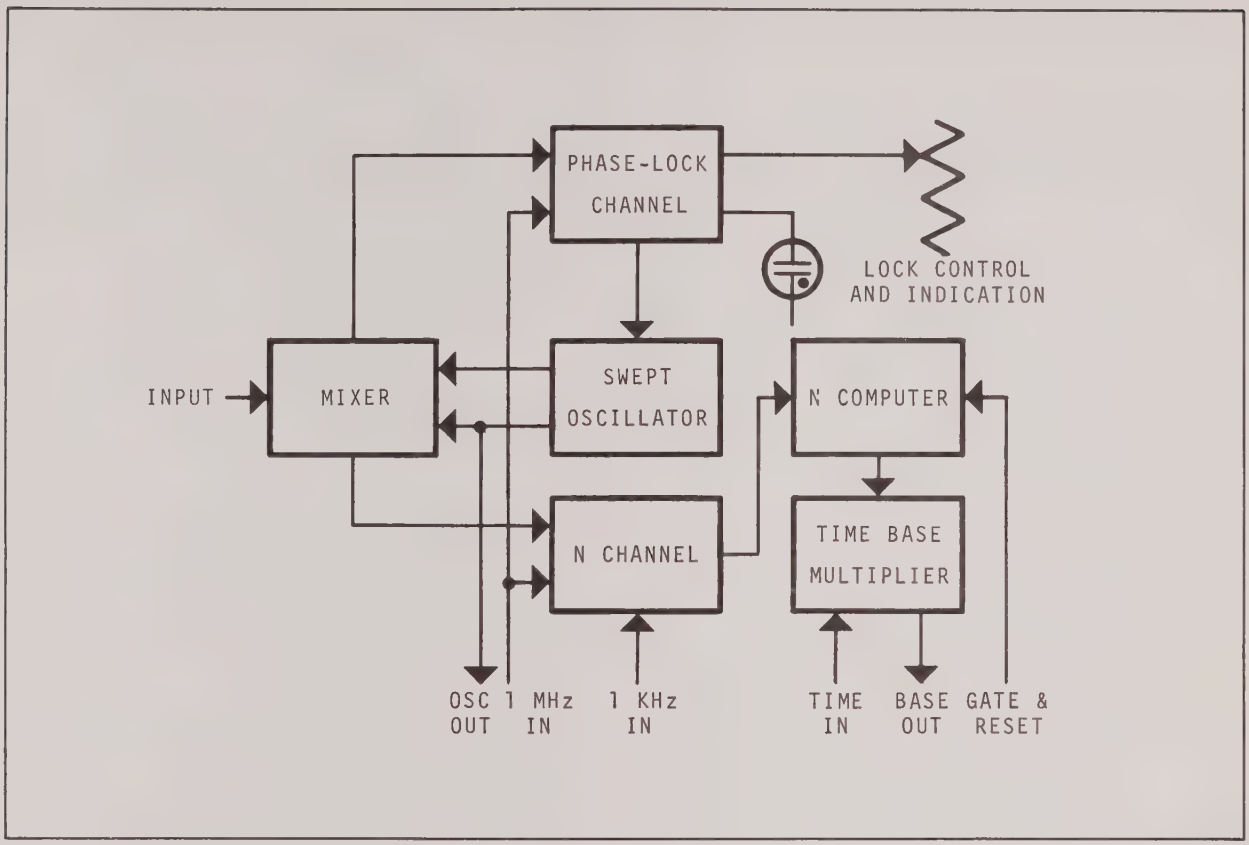


Figure 4-8. .2-12.4 GHz ACTO, Basic Block Diagram

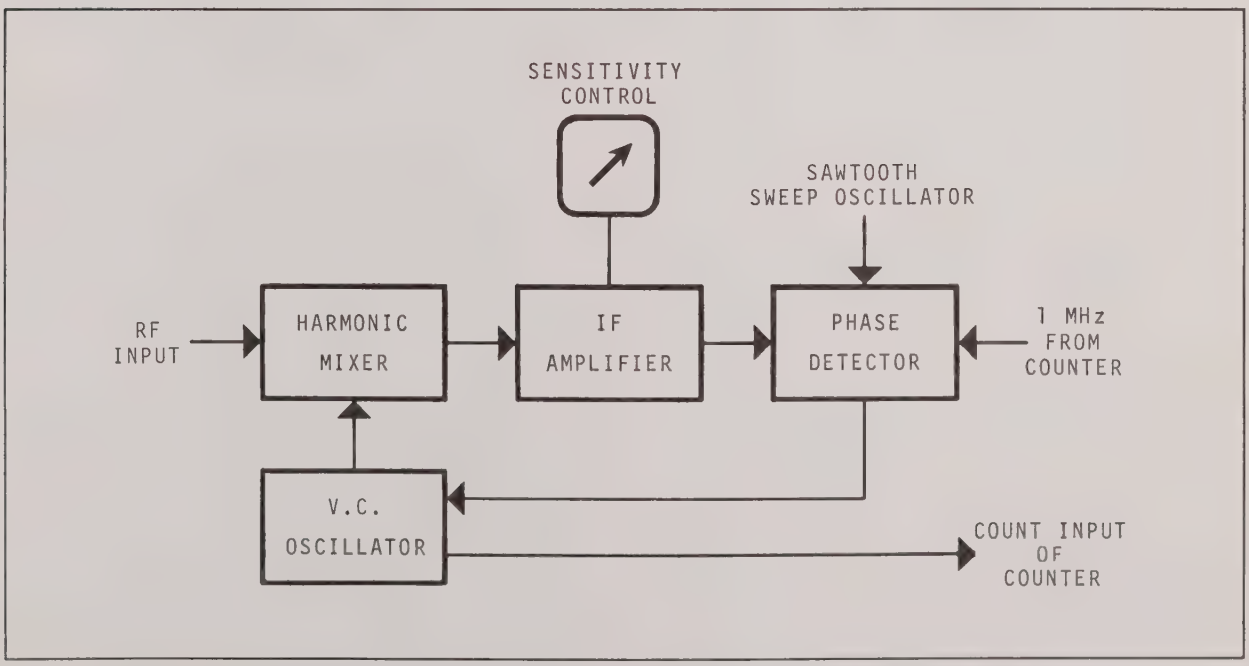


Figure 4-9. ACTO Phase Lock Channel, Block Diagram

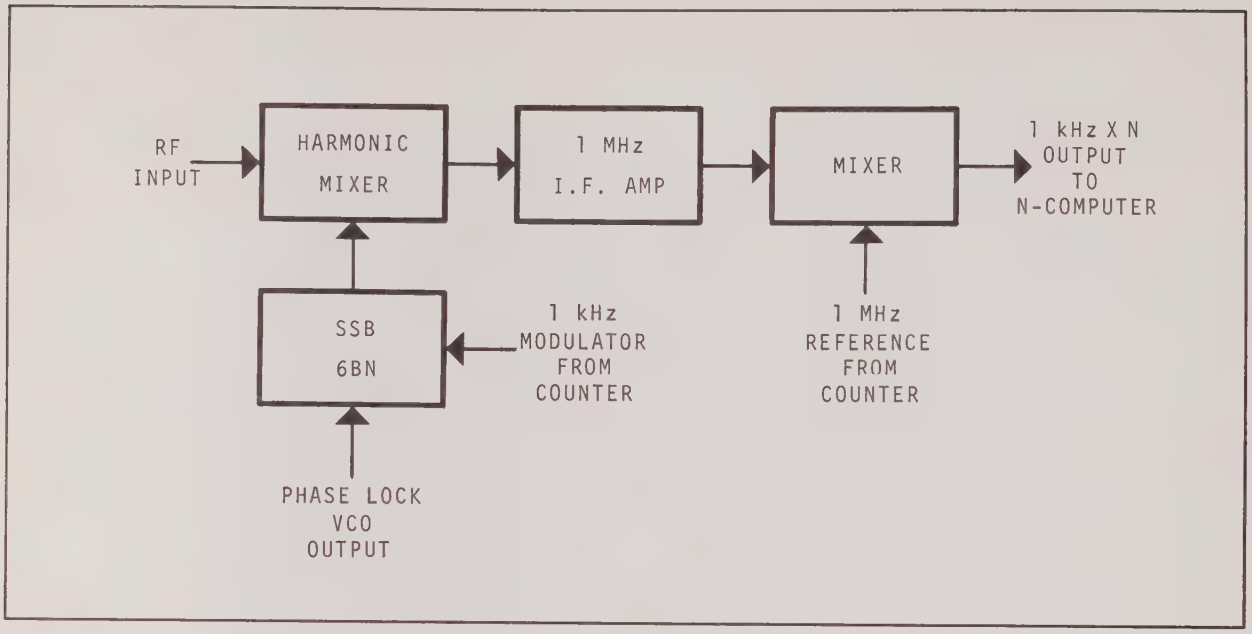


Figure 4-10. ACTO N-Channel, Block Diagram

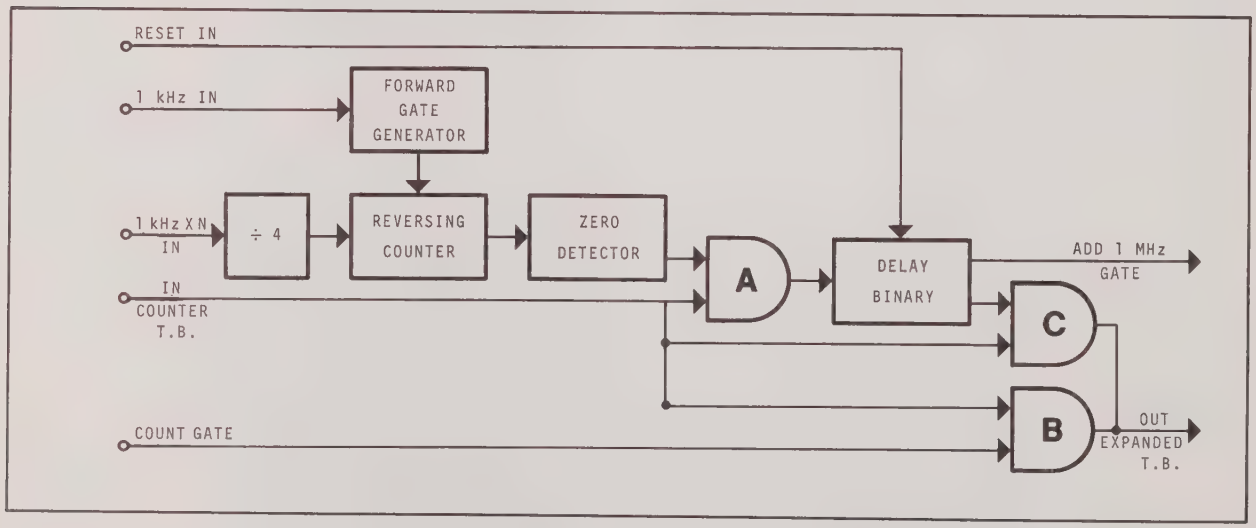


Figure 4-11. ACTO N-Compute, Block Diagram

Figure 4-10 shows the basic diagram for the ACTO. It uses an oscillator, a harmonic mixer, an IF Amplifier, and a phase detector to constitute a phase lock loop. In the absense of any RF input signal, or in the case where the sensitivity control is turned to minimum, there is no signal present on the output of the IF Amplifier. The sweep oscillator is free to run, thereby sweeping the oscillator over a narrow band of frequencies.

Any of several harmonics of this oscillator are capable of mixing with the RF signal to provide a one megahertz IF signal. If an RF signal is present and the sensitivity is increased, one of these

harmonics will produce an IF frequency of one megahertz. This signal is then phase-compared to the one megahertz from the counter. When this happens DC is generated on the output of the phase detector and this voltage controls the oscillator, providing a phase lock. As soon as this occurs, the sweep oscillator is overridden and is no longer able to sweep the oscillator. Thus, the oscillator is tuned to a frequency which is an exact sub-multiple of the input frequency with a one MHz offset.

A second output from the oscillator is applied to the count input of the counter so that the counter can measure the exact frequency of this oscillator.

Figure 4-8 shows a more complete block diagram of an automatic transfer oscillator, which includes components being measured. In this case a third output from the oscillator is used to drive a single side band generator. This generator is modulated at a 1 kHz rate. The resultant output of this side band generator is equal to the oscillator frequency shifted in frequency by 1 kHz. This shifted frequency is then amplified and applied to a second harmonic mixer. The RF input is applied to both harmonic mixers by a means of resistive power splitter. When the first channel (called the lock channel) achieves a phase lock, it produces an exact 1 MHz IF, since it is phase locked to 1 MHz. However, the output of the second harmonic mixer would not be exactly 1 MHz, because the signal driving this mixer is one kHz different from the first. The actual output frequency would be 1 MHz, plus or minus 1 kHz times the harmonic number. For example, if the RF signal is mixing with the 100th harmonic of the oscillator, it also must be mixing with the 100th harmonic of the output of the single side band generator. This 100th harmonic is different in frequency by 1 kHz times this harmonic number (N) or 100 kHz. The resultant IF frequency is either 900 kHz or 1100 kHz, which is amplified in the IF amplifier and applied to a mixer and mixed with 1 MHz. The different frequency is one kHz times (N).

The function of the N-Computer portion of the ACTO circuit as shown in Figure 4-11, is to gate out the VCO signal, to extract "N" from the 1 kHz x N input, and to expand the counter's time base as required for an accurate count.

Since the original 1 kHz modulation frequency and the 1 kHz x N frequency are both present, it is possible to compare the two digitally and extract "N". Having done this, the circuit expands the counter's time base period by the factor N + 1, and generates an "add 1 MHz" gate. During the N time base period, the counter counts the 1 MHz frequency for an additional time base period, and the cumulative total count is displayed by the counter. The additional counting of 1 MHz compensates for the 1 MHz error introduced in the IF stages.

Gating of the VCO frequency and the 1 MHz takes place in the 300 MHz Prescaler in IC's 2 and 3.

The Sweep Oscillator (Schematic #23730, sheet #3)

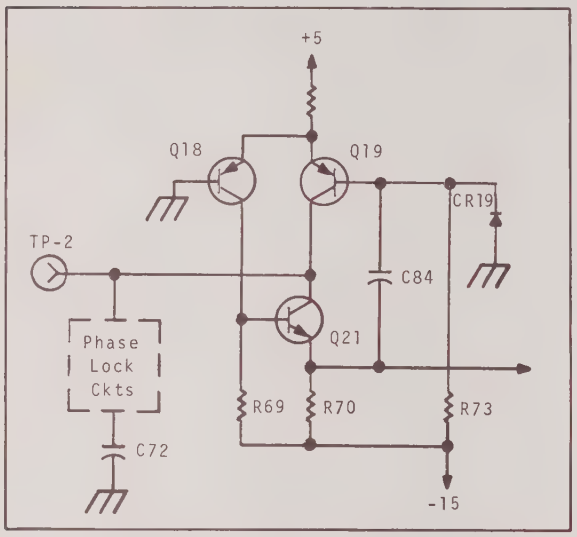


Figure 4-12. Sweep Oscillator, Schematic

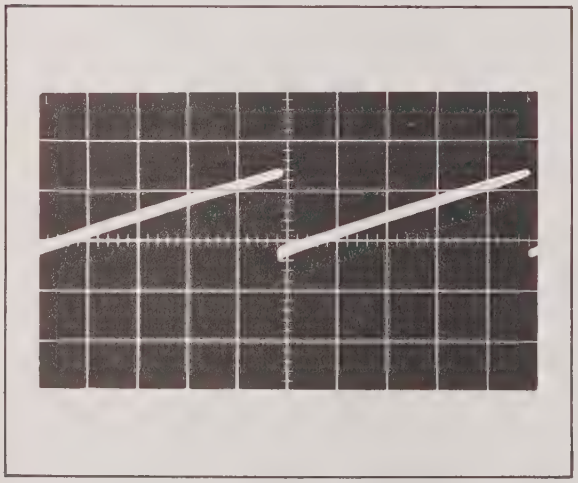


Figure 4-13. Sweep Oscillator, Wave Form

At the start of a cycle in this circuit, Q19 in on, and drawing base current through R73 from the -15V supply. In this condition, Q19 takes all the available current through R67, which holds Q18 in the off condition. Q21 will also be off, so that Q19 will have to obtain its collector current from capacitor C72 in the VCO circuit. The path from C72 to Q19 leads through the Phase Lock Detector circuits which act as a switch during phase lock to stop the sweep oscillator.

As C72 charges towards plus 15 volts, it tunes the VCO down in frequency until Q19 becomes saturated. When this happens, Q19 must obtain all of its emitter current through its base circuit. This current flow is held to a small value by R73 which will allow the emitter voltage to rise. As a result, Q18 will begin to receive emitter current and will turn on. When Q18 is turned on, its collector current is felt on the base of Q21, turning it on. The emitter of Q21 drives the base of Q19 positive, through C84, which turns it off, and Q18 turns on harder. The collector of Q21 supplies ample current to discharge C72 and C84 rapidly. The discharge of C72 drives the dawtooth waveform to near minus 15 volts. The discharge of C84 permits Q19 to turn on again, to repeat the cycle. The cycle is repeated until a phase lock occurs to stop it.

In the Lock Gate circuit, Q23 is held on during the time C72 is being charged and the sawtooth ramp is going positive. With Q23 on, capacitor C85 will hold the gate of Q22 closed (off). This condition remains as long as the Sweep Oscillator is running. When the Sweep Oscillator stops due to phase lock, Q23 turns off, C85 charges toward +15, Q22 turns on, and Q20 turns on to open the LOCK gate, and to provide a voltage to operate the front panel LOK lamp.

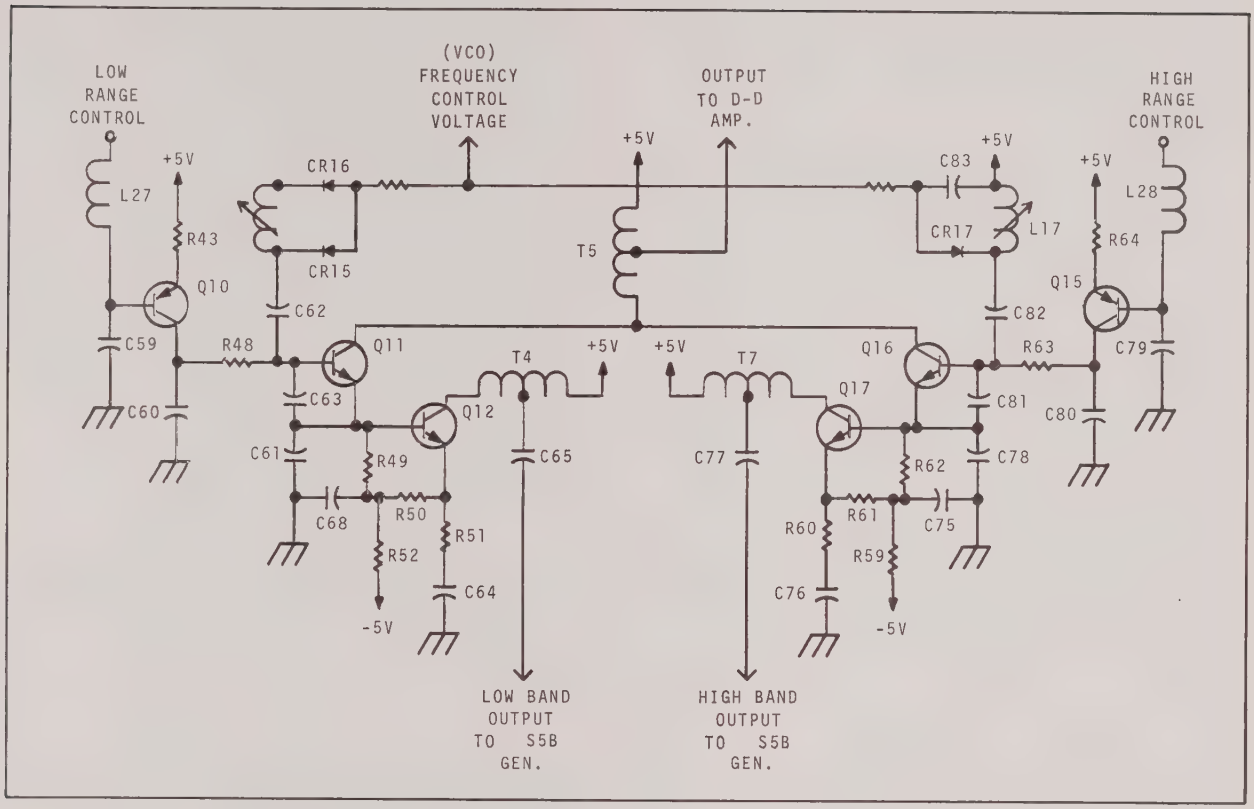


Figure 4-14. Voltage Controlled Oscillator (VCO), Schematic

The VCO is actually two separate oscillator circuits, a low band (30-33 MHz) and a high band (98-100 MHz), both controlled from a common sweep oscillator input and feeding a common push-pull output. Q11 is the low band oscillator, and A16 is the high band oscillator. Since both operations are similar, only the low band circuits will be discussed.

When the front panel RANGE switch is placed in the .3-3 GHz (low) ACTO range position, a ground appears on the base of Q10 turning it on. Q10 turns Q11 on. A11 and its associated components form a conventional Colpitts oscillator circuit whose tank circuit includes varicap diodes CR15 and CR16 as its capacitive element. The rising sawtooth of voltage from the sweep oscillator increases varicap capacitance, and so sweeps the VCO frequency downwards. Circuit values are selected to produce an output in this section varying between approximately 30 and 33 MHz.

The main output of the oscillator is taken from the collector of Q11, and is transformer coupled through T5 to a push-pull output amplifier Q13/Q14. The amplified output is then transformer coupled through T6 to the lock channel mixer at terminal 2, and to a voltage divider. The divider, consisting of R56 and R58, attenuates the output level available on terminal 6, which is supplied to the counter.

A second output is taken from the oscillator through the emitter of Q11 and fed to the base of Q12. Q12, acting as a buffer amplifier, supplies the oscillator output to the low band portion of the single side band generator circuit at IC29/IC30.

The 1 kHz Filter (Schematic #23730, sheet #3)

This circuit consists of Q24, Q25, Q26, Q27 and their associated components. It works to first filter out all unwanted frequencies from the 1 kHz input, and then to produce two outputs separated by 90° in phase.

Single Side Band Generator (SSB) (Schematic #23730, sheet #3)

The 1 kHz signal is applied to the base of Q27 through R88 and R85. The collector of Q27 is coupled to the gate of source follower Q24 through a twin-T filter made up of R78/R70/C86 and C88/C130/R80. The source of Q24 is coupled back to the base of Q27. This circuit provides 100% negative feedback to all frequencies except 1 kHz. The 1 kHz output is coupled through C89 to isolation/phase-shift amplifiers Q25 and Q26, where dual 1 kHz signals are produced separated in phase by 90°. A pair of these signals is fed to each portion of the SSB Generator circuit.

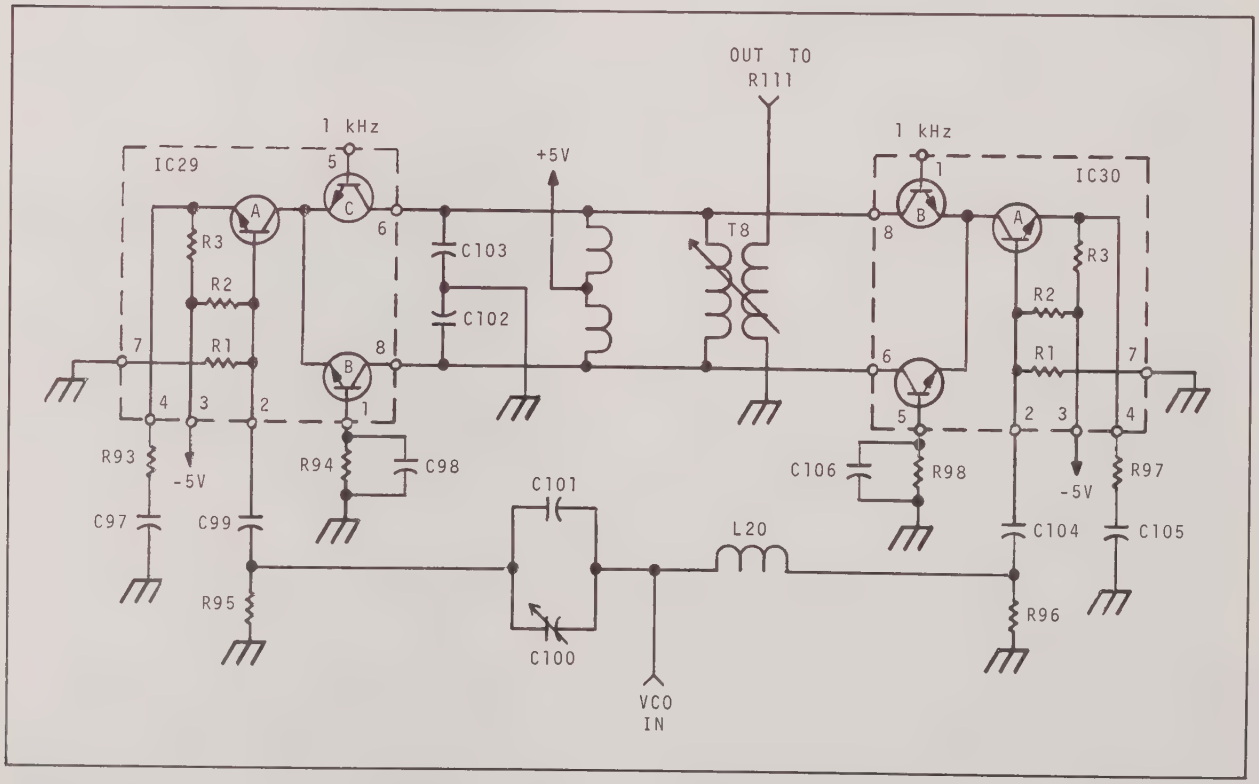


Figure 4-15. Single Side Band Generator (SSB), Schematic

The function of this circuit is to shift upward by precisely 1 kHz the signal frequency received from the VCO. Like the VCO, this circuit is really two nearly identical circuits whose operations are very similar. Therefore, only

the low band portion will be discussed.

The input from the VCO is coupled to terminal 2 of IC29 through a capacitive phase lead network (C100/C101), and to terminal 2 of IC30 through an inductive phase lag element (L20(. The net result is VCO input signals to the two IC's 90° out of phase.

The two out-of-phase 1 kHz signals from the 1 kHz Filter are also fed to the IC's. Since the operation of the IC's is identical, only IC29 will be discussed.

In IC29, when the signal on terminal 5 is 0 volts, the outputs at terminals 6 and 8 are balanced and no output is available from the secondary of T8. The VCO signal, which is fed to terminal 2, will therefore appear at T8 only when terminal 5 is <u>not</u> 0 volts, and will be proportional to its departure from 0 volts. The RF contained in odd numbered half-cycles is 180° out of phase with the RF contained in even numbered half-cycles.

The similar output from IC30 also appears on the secondary of T8. However, since all inputs to IC30 are 90° out of phase with their IC29 counterparts, the phase of the resultant composite signal on the secondary of T8 will be 0° then 90°, 180°, 270° and back to 0°. This phase rotation will occur at a 1 kHz rate and result in a frequency equal to the VCO frequency shifted upward by 1 kHz. The 1 kHz adds to the VCO frequency due to the overall rotating phase relationship of the four inputs, as shown in Figure 4-16.

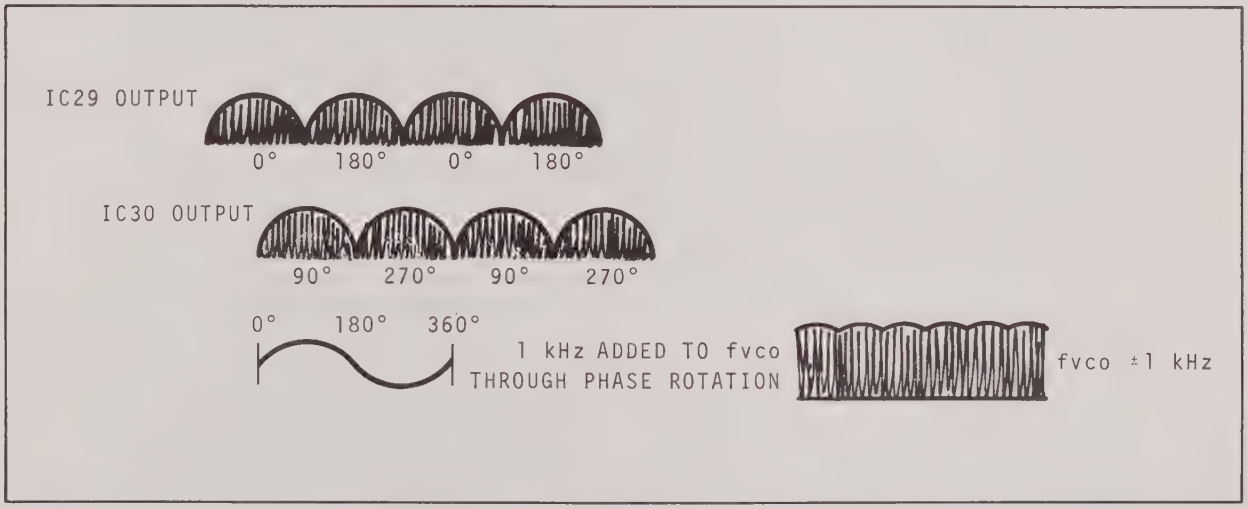


Figure 4-16. Rotating Phase Relationship, Wave Form

The IC29/IC30 low band signal is fed to the base of Q28 through R111. The IC31/IC32 high band signal is fed to the base of Q28 through IC21. The collector of Q28 is transformer coupled through T10 to push-pull amplifier Q29/Q30. The output of this stage is likewise transformer coupled out and is available on terminal 1 from where it is used to drive the N-Channel Mixer.

<u>IF Amplifier Circuits</u> (Schematic #23730, sheet #2)

The ACTO circuit includes two nearly

identical IF Amplifier circuits which amplify the output signals from the Phase-Lock and N-Channel mixers. The SENSITIVITY control is tied into the first stage of the lock channel IF circuit.

The output of the mixer is coupled through R120 and C27 to terminal 2 of IC27. IC27 is connected to operate as a single-ended two stage amplifier, with the bandwidth increased by damping L7 with R20, and is fed to IC28. IC28 is a multi-stage high gain amplifier/limiter which further amplifies the IF signal for use in driving the next stages.

N-Channel IF Mixer

The N-Channel IF Amplifier is similar to the lock channel IF. The output of the N-Channel IF amplifier, at IC26 terminal 5, is coupled to a balanced mixer circuit at the secondary center-tap of transformer T1. A 1 MHz signal from the counter, through Q7, is fed to the primary of T1. The mixer output becomes 1 kHz x N. It passes through a low pass filter, composed of C20/L5/C18/C21/C19, to the Q2/Q3 schmitt trigger circuit. This circuit shapes the 1 kHz x N signal for use in the N-Compute circuitry.

Lock Channel Phase Detector

This circuit includes two separate but similar phase detector circuits. The "Phase Lock" phase detector includes T2, CR9, CR10, Q6, and other associated components.

The "Phase Lock Error" phase detector circuit includes T3, CR11, CR12, Q5, and other associated components.

Figure 4-17 shows a simplified version of the "Phase Lock" detector circuit.

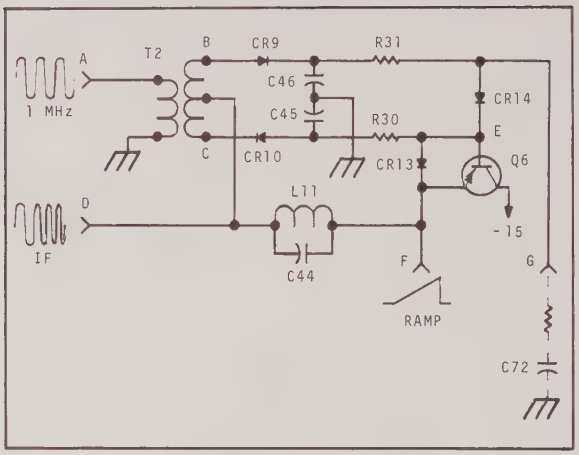


Figure 4-17.
"Phase Lock" Phase Detector, Schematic

The "Phase Lock" phase detector is a circuit which compares a 1 MHz reference frequency with the IF frequency from the lock channel mixer, and developes a voltage which isproportional to the phase difference between these two frequencies. This voltage appears between the IF input (D), and the base of Q6 (E). Q6 amplifies this voltage and, as the phase difference between these points becomes constant, supplies current to ramp generator Q19 in the sweep oscillator and stops the sweep.

Without an RF input there is no IF signal from IC28, and the current produced for the ramp generator pulls the emitter of Q6 toward +15 volts. While most of this current passes through the L11/T2 part of the circuit, some passes through Q6 and CR14, holding Q6 off. This current charges C72, to produce the positive sawtooth of voltage used to sweep the VCO.

When an RF signal is applied to the ACTO, the resultant swept IF will generate many zero beats with the 1 MHz reference frequency. As the SENSITIVITY control is increased (cw - to +), these zero beat signals will become larger and

larger, so that when a true zero beat is obtained, the phase difference between IF and reference will cause the voltage on the base of Q6 (E) to become negative. This turns Q6 on, and all the current from the ramp generator Q19 (F) will be absorbed by Q6. When this happens C72 stops charging and holds its charge level. This steady state of C72 holds the VCO on-frequency to maintain the phase lock condition. Anything which might change the phase relationship between IF and reference will cause the detector to shift the VCO slightly to cancel the effects of the change.

A visualization of phase lock occuring can be obtained as shown in Figure 4-18.

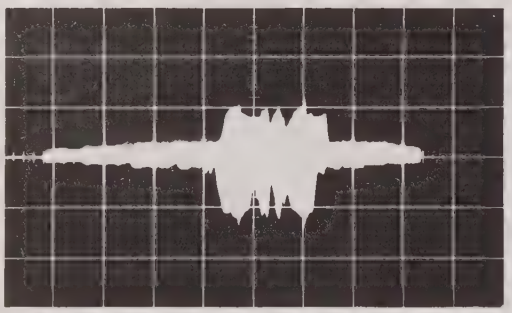


Figure 4-18a.
Zero Beat Before Phase Lock, Wave Form

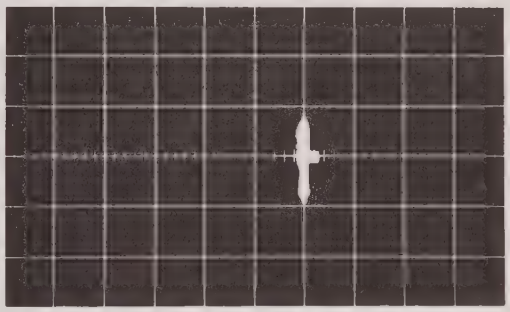


Figure 4-18b.
Zero Beat After Phase Lock, Wave Form

Figure 4-18. Zero Beat Phase Lock, Wave Form

Figure 4-18a shows the zero beat signal condition just prior to the occurance of a phase lock. Figure 4-18b depicts the signal with phase lock having occured. The following procedure may be used to duplicate the illustrations with your instrument:

1. Apply a 3 GHz signal at -15 dBm to the counter.
2. Set the oscilloscope to EXT. HORIZ. Apply the signal from ACTO TP2 to the oscilloscope horizontal input.
3. Apply the ACTO TP1 signal to the oscilloscope's vertical input.
4. Set the SENSITIVITY control full ccw, but not into detent. Observe a signal similar to Figure 4-18.

NOTE

The number of zero beats observed is determined by the input frequence and the selected ACTO range.

5. After obtaining correct display, slowly rotate the SENSITIVITY control cw until the LOK annunciator lights.
6. Observe that the oscilloscope display has collapsed to one vertical line located on the leading edge of the second pulse of one of the displayed zero beats.

Phase Lock must be made on the correct side band. Should the lock-on be incorrect, the counter would display an answer 2 MHz too high. To prevent this, the "Phase Lock Error" phase detector circuit was included. This circuit operates much like the Phase Lock circuit, except that its 1 MHz reference signal, fed to T3 from Q9, is 90° out of phase with that supplied to T2 from Q8. A negative output at the base of Q5 indicates that phase lock has occured on the wrong side band. In this case, Q5 turns on to prevent Q6 from clamping the sweep ramp, and creating an erroneous phase lock.

N-Compute Circuits (Schematic #23730, sheet #1)

The N-Compute circuits convert the 1 kHz x N signal from the N-Channel IF amplifier to a number N. When the counter is gated on to count the VCO frequency, the number N is used to multiply the counter's measurement period so as to make the displayed reading a direct representation of the RF being measured.

In operation, when the ACTO is phase locked to the unknown RF input, the counter's reset pulse enables this circuit to initiate the computation.

Upon receipt of a reset pulse, decade IC21 is reset, which enables the gate IC23D, through IC24A, allowing IC21 to begin counting the 1 kHz pulses present at terminal 21. IC21 counts these pulses until it reaches the count of 9. IC24A detects the 9-count, and turns IC23D off to stop IC21. The output of IC24A is also the forward gate, which is applied to the forward-reverse binary counter IC1-IC8 enabling a forward count as long as IC21 is counting. When IC21 reaches the count of 4 it enables the JK lines of the dual JK flip-flop IC14, permitting IC14 to accept the 1 kHz x N signal and divide it by 4. The resultant $\frac{1\text{ kHz} \times N}{4}$ signal is then counted in the forward direction into the forward-reverse counter. IC14 is stopped when IC21 reaches the count of 8. IC14 has thus been dividing the input by 4 for a period of 4 msec (between IC21's counts of 4 and 8), resulting in the expression $\frac{(1\text{ kHz} \times N)}{(4\text{ kHz})}$ 4. When this expression is simplified only N remains, which is the number stored in the forward-reverse counter.

Approximately 50 msec after the reset pulse, the counter is able to accept a start pulse. Upon receipt of a start pulse, the gate line (terminal 22) goes to the "1" state. This enables IC16A and allows the time base pulses to go through IC16C, IC18B, IC18C, IC16A, and out through terminal 12 back to the counter. The first pulse will cause the counter's gate to open, bringing terminal 22 to the "0" state, disabling IC16A. Subsequent time base pulses will leave IC18B and go through IC10B to drive the forward-reverse counter in the reverse direction. The counter will then count from N back toward zero. A coincidence circuit of IC24B, CR1, CR2, CR3, and CR4, detects when the reversed counter reaches zero. At this point IC22D pin 11 goes to the "1" state, which permits the next time base pulse to pass through IC22A and drive the JK flip-flop IC19. This occurs when the counter gate has been open for N time periods. During this time the counter has been counting the ACTO's VCO frequency. To obtain a direct indication of the unknown RF frequency, 1 MHz must be added to the reading. IC19 operates the two gate circuits IC2 and IC3 in the 300 MHz Prescaler circuit. In operation, the VCO drive to the counter is turned off at the end of the N per-

iod, and the 1 MHz signal is turned on and counted for one additional time base period. The next time base pulse through IC18A and IC16B to terminal 12 stops the counter.

The Q1 circuit supplies a "clear" signal to IC19, at the end of the N period, which is coincident with the trailing edge of the controlling pulse. This permits the "add 1 MHz" gating to occur without allowing the controlling stop pulse to actually stop the counter. The next time base pulse feeds through to stop the counter after the "add 1 MHz" gate.

4.3.4 Frequency Function (Schematic #23388, PC Ass'y #19941)

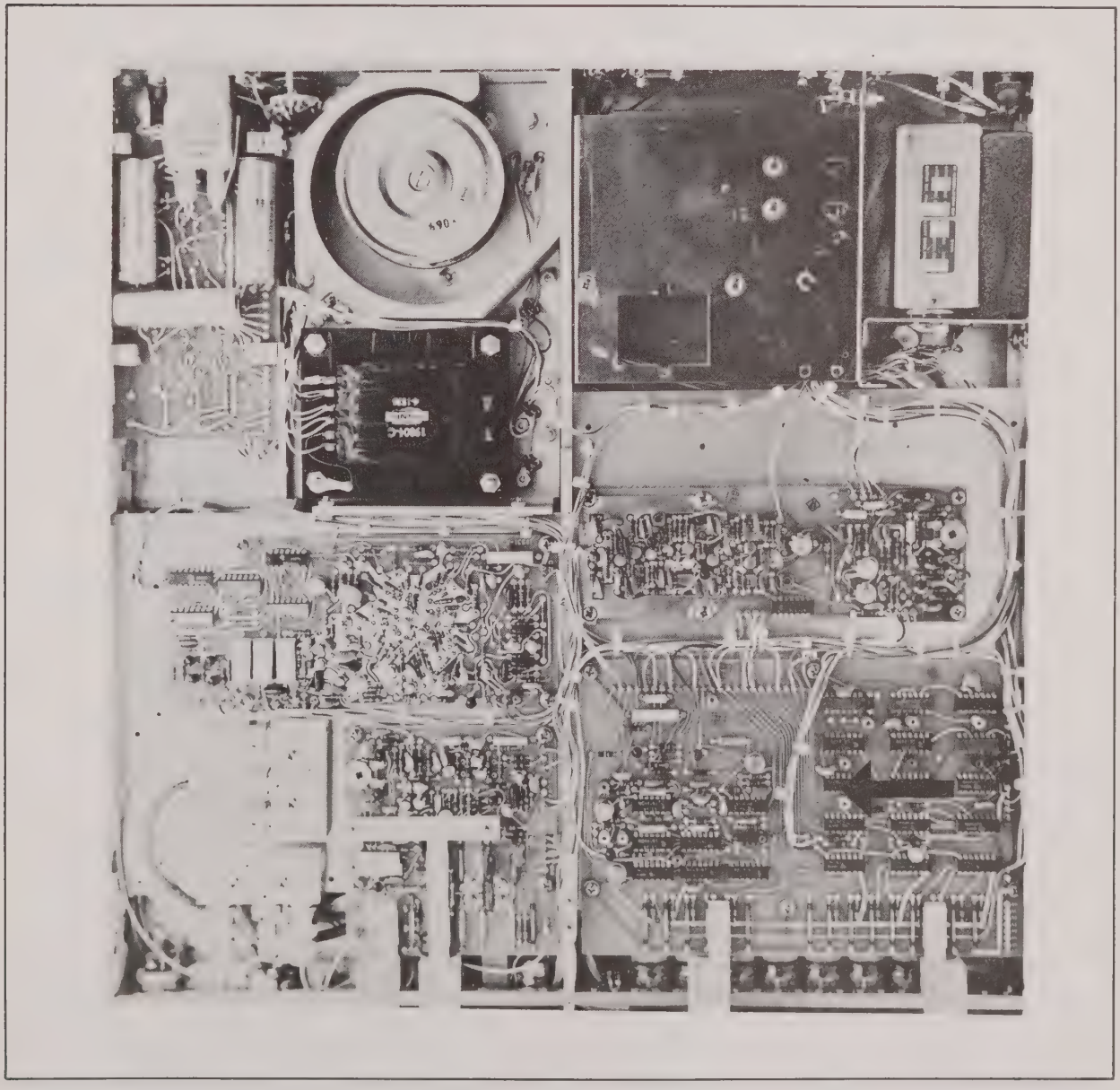


Figure 4-19. Frequency Function Board, Location

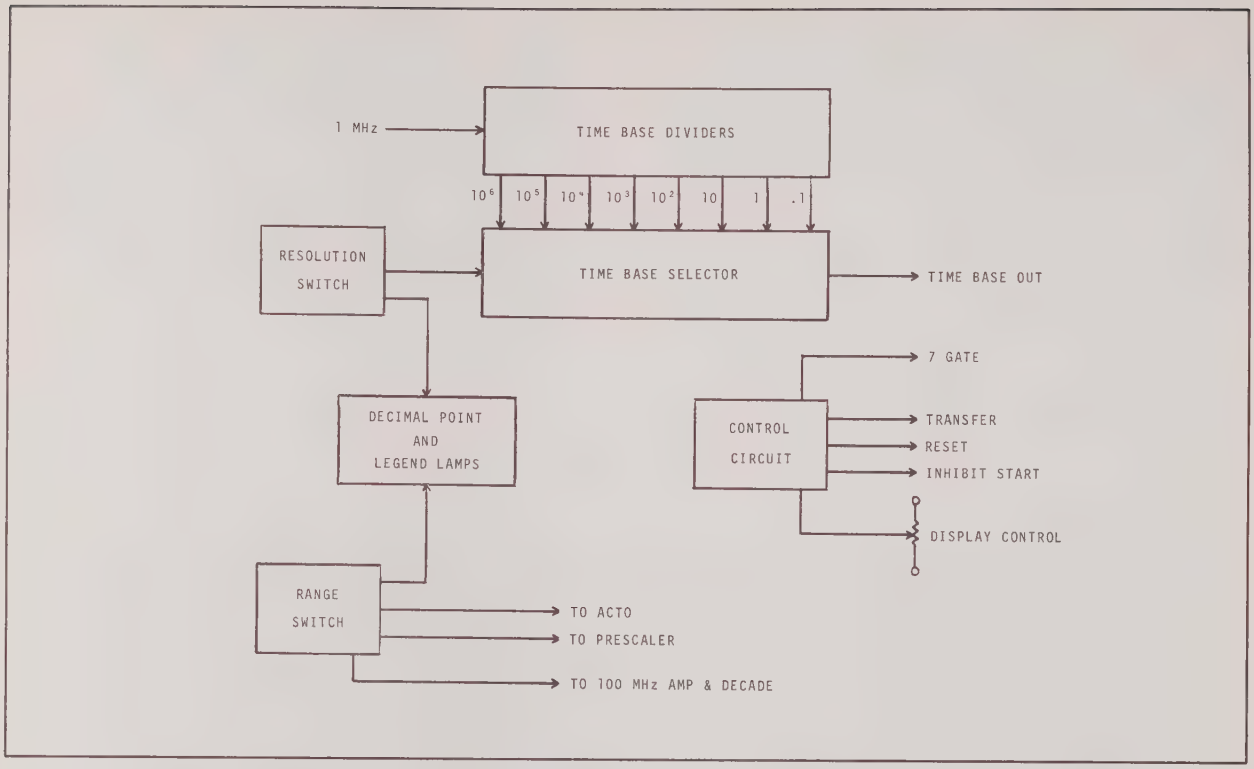


Figure 4-20. Frequency Function Board, Block Diagram

NOTE

This PC assembly is common to several Systron-Donner instruments. Not all of the circuits present are used in this instrument.

The front panel RANGE and RESOLUTION slide switch arms activate magnetic need switches on this assembly. These switches and their associated DTL circuits control the operation of the instrument by providing time base, gating, and control circuit ground paths for the operation of circuits on other assemblies.

Movement of the RANGE switch slide arm controls switches S10 through S15. Switch closure grounds an IC input circuit, and changes its negative output signal level to positive. In the TEST position, S11 is closed grounding pins 1 and 2 of IC3A. Pin 3 of IC3A then goes positive. This positive signal passes through connector 39 to connector 7 on the 100 MHz Amplifier of Decade assembly, here it is applied to the base of Q1 to energize coil C1 and close switch S1. S1 feeds the 1 MHz reference signal in as a test signal. Closure of S12, S13, S14, and S15 provides a ground at connectors 19, 16, 15, or 44 respectively (corresponding IC outputs are not used). These particular ground signals perform a function similar to that described for the TEST position. Closure of any one of these switches causes the corresponding input signal to be channeled into the 100 MHz Amplifier of Decade circuit.

Movement of the RESOLUTION switch slide arm controls switches S1 through S9. Closure of one of these switches places

a ground on three IC input circuits. One of these circuits controls the operation of an annunciator legend light, the second controls operation of one of the display tube decimal point indications, and the third selects the proper time base frequency. As an example, setting the RESOLUTION slide to "1" closes S2. S2 closed places a ground on pin 2 of IC6A, pin 13 of IC6D, and pins 12 and 13 of IC1D. Grounding either input to IC6A energizes the decimal point indicator in display tube V3 to produce a reading of 000000.000. Grounding either input of IC6D energizes annunciator lamp I5 through Q5 to illuminate the "kHz" legend. Grounding the inputs of IC1D places a position signal on pin 2 of IC8A, enabling the 1 count/second output from IC19 to pass through to IC6B and the rear panel T.B. OUT connector, and to terminal 1.

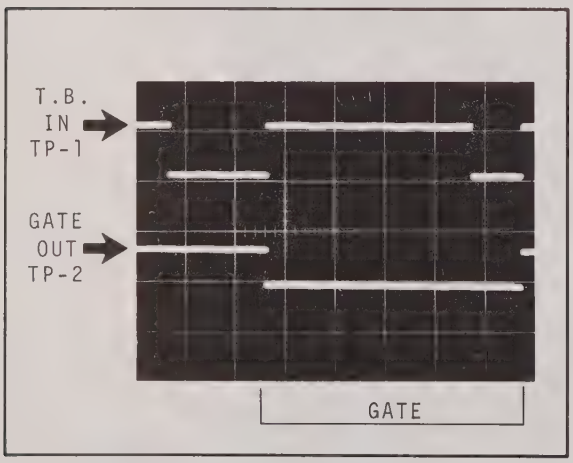


Figure 4-21.
Frequency Function Board, Wave Forms

The time base pulse train at terminal 1 is channeled through the ACTO circuits and back through terminal 2 (TP1) to Count Gate control IC21 and IC22 where it is applied to these two J-K Flip-Flops as a clock pulse train. IC21 output pin 8 goes negative and IC22 output pin 8 goes positive with the end of the first pulse of the count train. This condition enables the count gate at terminal 38, (TP2) through IC11C, and the front panel GATE lamp through IC13D, IC13B, and transistor Q4 to terminal 5. The output of IC13D is also coupled through capacitor C11 to IC10A and IC10B. This circuit functions to ensure that the GATE lamp will remain long enough to be visible, regardless of how short the gate itself may be.

At the end of the second pulse in the count train the condition of IC21/IC22 reverses. This ends the count gate through IC11C, deenergizes the GATE lamp through IC13D/IC13B and Q4 (unless the GATE Light one-shot keeps it on for a short time), produces the End-of-Count gate through IC13A/Q3 to terminal 6, triggers the reset pulse through Q1, and the transfer pulse through pin 2 of IC12A. The reset pulse at TP5 is delayed by the Q2 circuit and occurs after the transfer pulse at TP6. This delayed pulse is also coupled to the time base inhibit one shot circuit IC9A/IC9D. The leading edge of the resultant time base inhibit pulse (TP3) clears the count gate control IC's, IC21/IC22, and through IC9B inhibits the last three decades of the time base chain. By inhibiting these decades, the count sequence is assured of control on the first clock pulse in the 10, 1 and .01 RESOLUTION ranges. Reset pulse delay time is controlled by the front panel RECYCLE RATE control through terminal 8 and R37 to Q2. A reset pulse can be generated at any time by grounding terminal 11 using the front panel manual RESET push-button. Manual reset signals produce the same control pulses as the automatic sequence.

This circuit accepts signals from the 1 MHz reference oscillator, the 100 MHz

A & B Amplifier, and the 300 MHz Prescaler. These three inputs are applied to magnetic reed switches S1, S2, and S3 respectively, whose operation is controlled by the RANGE switch. The selected input signal is coupled through R4 to input amplifier Q1/Q2 (waveform 1). The output of this amplifier is applied to Schmitt trigger circuit Q3/Q4 and shaper Q5. The shaped pulse output of Q5 (waeeform 3), is coupled to the collector of gate transistor Q6 and tunnel diode CR2. When the count gate (from the frequence Function circuit) is not present, Q6 is turned on shunting CR2 and preventing the input signal from reaching Q7. When the count gate enables CR2 (turns Q6 off), CR2, Q7, and Q8 further shape the signal (waveform 4), and apply it to the high speed "2" binary Q10/Q11 through R34. The output of this binary (waveform 5), equal to one half of the input signal frequence, is coupled through amplifier Q13 to gate inverter IC1, and the quinary stages IC2-4. The 1-2-4-8 decade output of these stages is coupled out to the Count Chain & Readout circuits through level translator IC's 5 through 8. At the end of the count gate, the entire count circuit is reset through Q20/Q16 and Q9.

4.3.5 100 MHz Amplifier and Decade (Schematic #33825, PC Ass'y #33288)

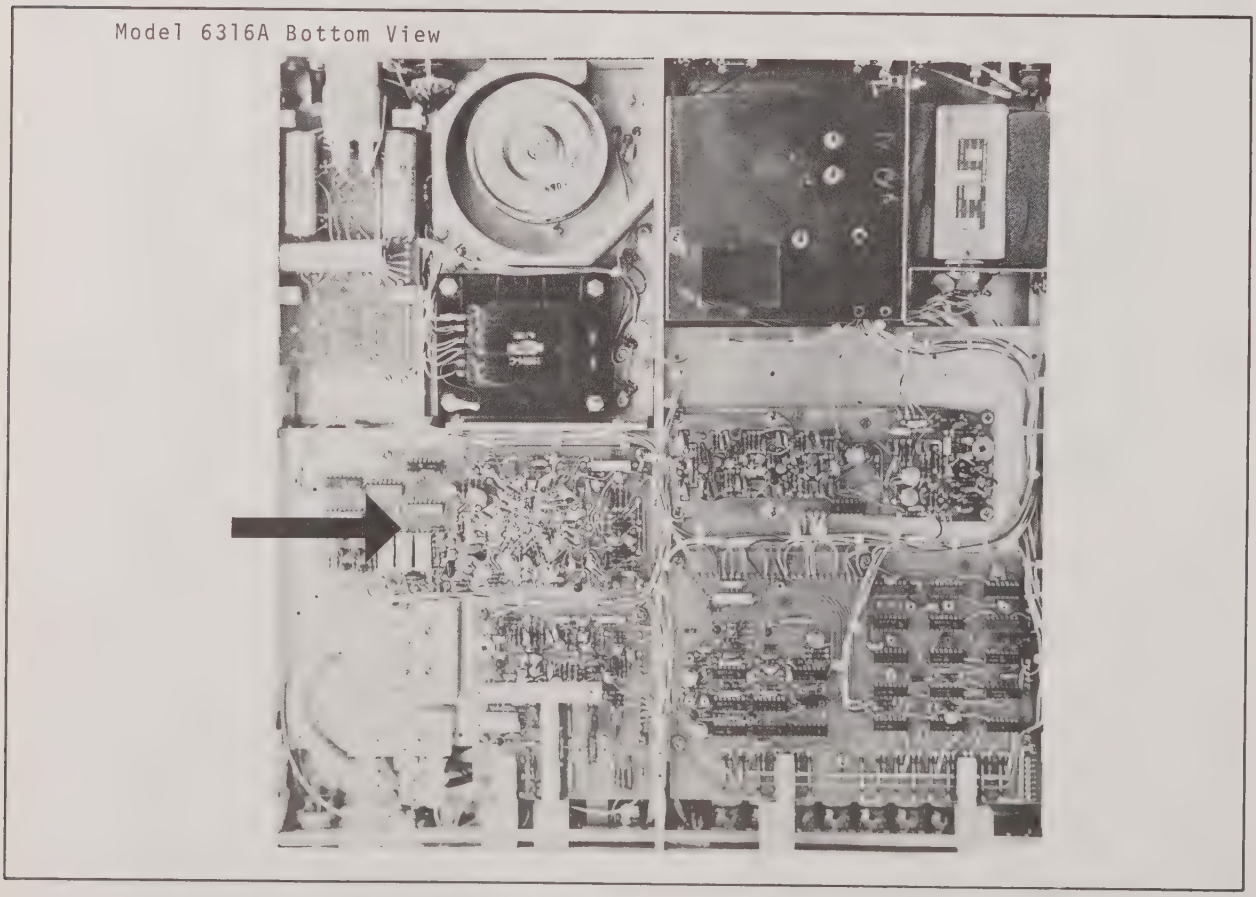


Figure 4-22. 100 MHz Amplifier & Decade, Location

100 MHz Amplifier & Decade

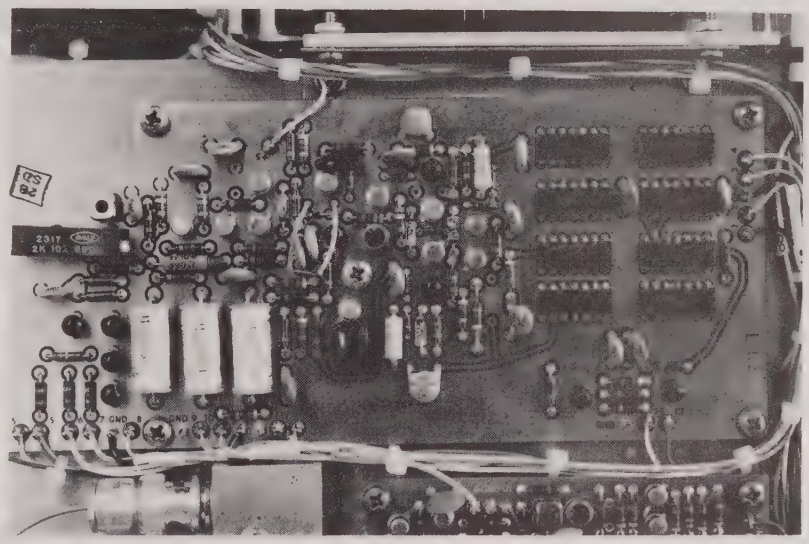


Figure 4-22. 100 MHz Amplifier & Decade, Location (con't.)

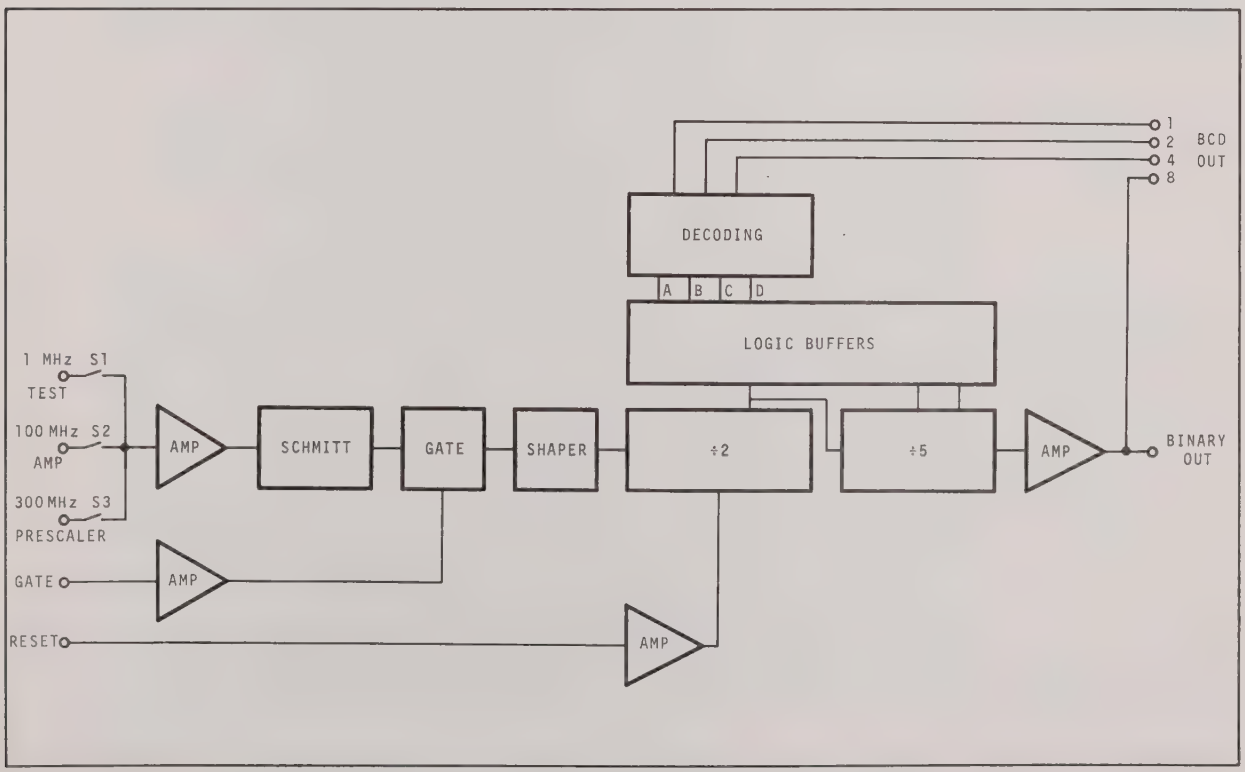
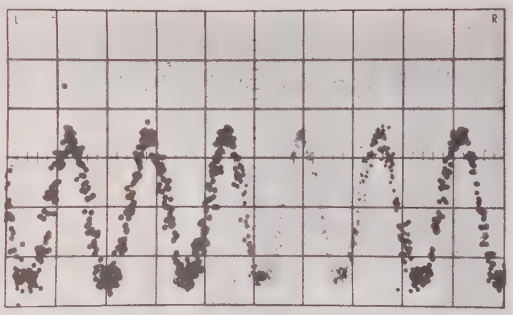
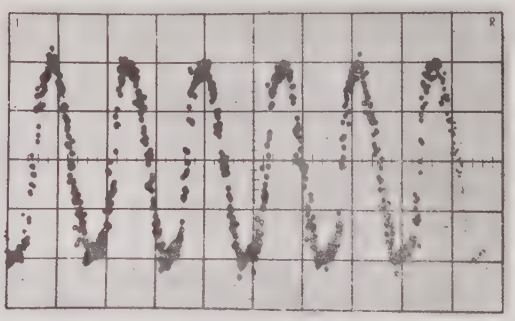


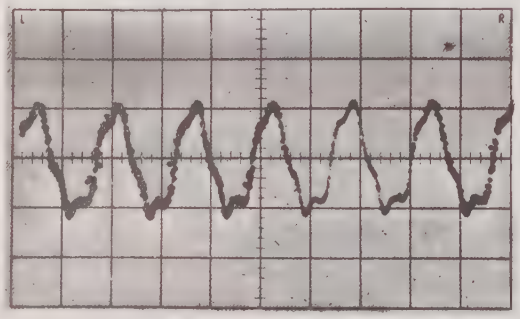
Figure 4-23. 100 MHz Amplifier & Decade, Block Diagram



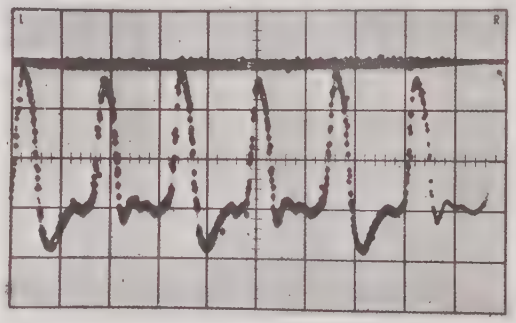
Waveform 1, Amplifier Input (125 MHz, 100 mV rms applied). Monitor R2 and R4 junction. Scope Settings: HORIZ, 5 nsec/cm and VERT, 50 mV/cm. Zero volts dc level.



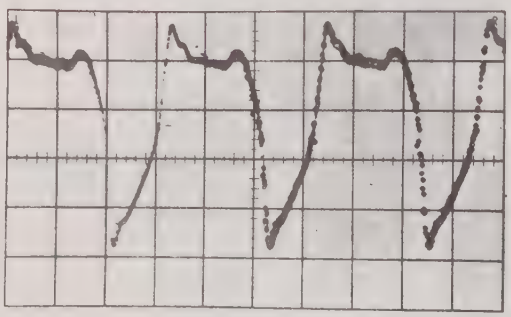
Waveform 2, Amplifier Output. Monitor Q1 collector. Scope Settings: HORIZ, 5 nsec/cm and VERT, 100 mV/cm. AC coupled. 1.55 V dc level.



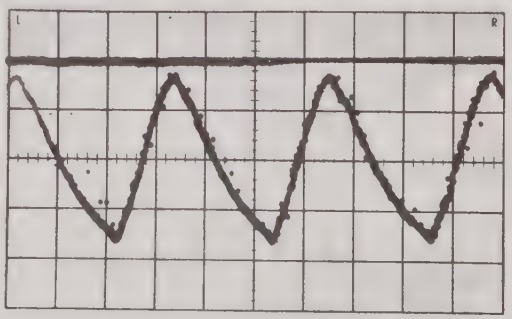
Waveform 3, Schmitt Trigger Output. Monitor Q5 emitter. Scope Settings: HORIZ, 5 nsec/cm and VERT, 200 mV/cm. AC coupled.



Waveform 4, Pulse Shaper. Monitor Q7 collector. Scope Settings: HORIZ, 5 nsec/cm and VERT, 200 mV/cm. DC coupled. Horizontal line is zero reference.



Waveform 5, Binary Output Emitter Follower. Monitor Q18 emitter. Scope Settings: HORIZ, 5 nsec/cm and VERT, 200 mV/cm. AC coupled.



Waveform 6, Binary Buffer. Monitor Q13 collector. Scope Settings: HORIZ, 5 nsec/cm and VERT, 1 V/cm. DC coupled. 0 reference at top.

Figure 4-24. 100 MHz Amplifier & Decade, Wave Forms

This circuit accepts signals from the 1 MHz reference oscillator, the 100 MHz A & B Amplifier, and the 300 MHz Prescaler. These three inputs are applied to magnetic reed switches S1, S2, and S3 respectively, whose operation is controlled by the RANGE switch. The selected input signal is coupled through R4 to input amplifier Q1/Q2 (waveform 1). The output of this amplifier is applied to Schmitt trigger circuit Q3/Q4 and shaper Q5. The shaped pulse output of Q5 (waveform 3), is coupled to the collector of gate transistor Q6 and tunnel diode CR2. When the count gate (from the Frequency Function circuit) is not present, Q6 is turned on shunting CR2 and preventing the input signal from reaching Q7.

When the count gate enables CR2 (turns Q6 off), CR2, Q7, and Q8 further shape the signal (waveform 4), and apply it to the high speed "2" binary Q10/Q11 through R34. The output of this binary (waveform 5), equal to one half of the input signal frequence, is coupled through amplifier Q13 to gate inverter IC1, and the quinary stages IC2-4. The 1-2-4-8 decade output of these stages is coupled out to the Count Chain & Readout circuits through level translator IC's 5 through 8. At the end of the count gate, the entire count circuit is reset through Q20/Q16.

4.3.6 Count Chain and Readout (Schematic #23197, PC Ass'y 19939)

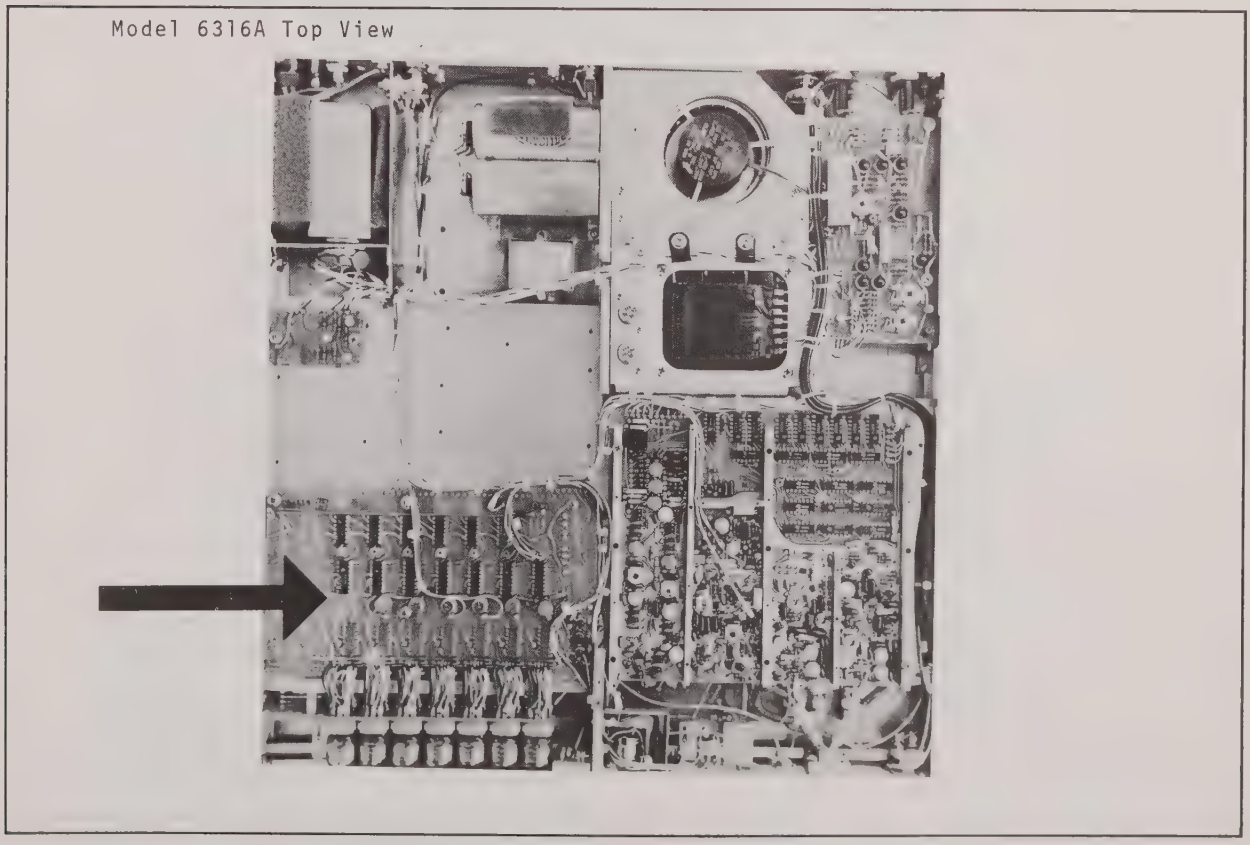


Figure 4-25. Count Chain and Readout, Location

Model 6316A Top View

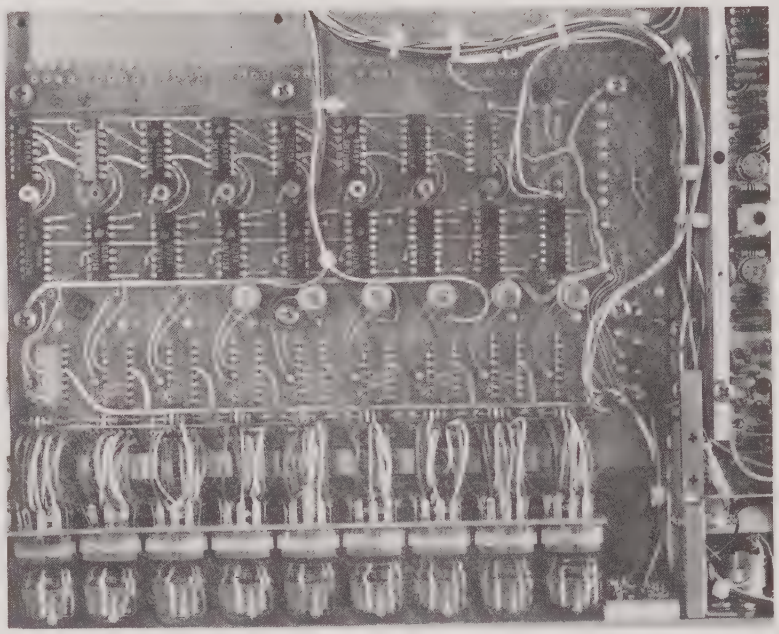


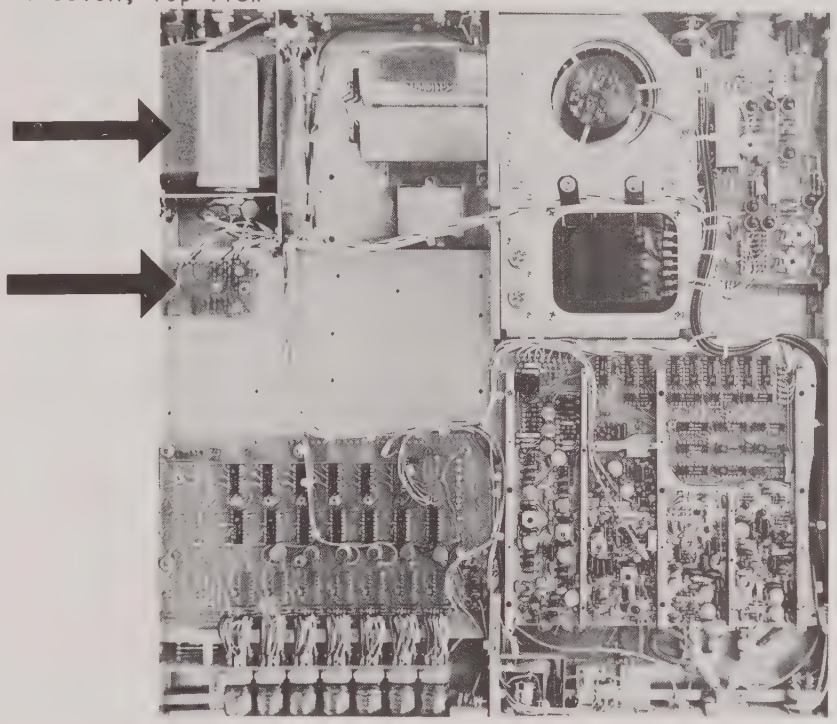
Figure 4-25. Count Chain and Readout, Location (con't.)

This circuit receives the 1-2-4-8 BCD and pulse chain from the 100 MHz Amplifier and Decade circuit. The BCD information is read into the first level count storage chain, consisting of IC's 2,5,6,8,9,11,12,14,15,17,18,20,21,23,24, 26, and 27. At the end of the count gate, the Frequency Function circuit produces a transfer pulse. This transfer pulse is supplied to the count chain IC's pins 4 and 13 through terminal 32. This pulse effects the transfer of the BCD information from the count chain to the second level decoder chain. This transfer empties the count chain in preparation for the next count cycle. The decoder chain, consists of IC's 1,4,7, 10,13,16,19,22, and 25.

Upon entering the decoder the 1-2-4-8 BCD information from the count storage, is immediately available as a 10 wire decimal code to activate the proper cathode in each associated display tube (V1-V9). Decimal point illumination control originates in the Frequency Function circuit and is coupled to the proper display tube decimal driver transistor Q6-Q13.

4.3.7 1 MHz Oscillator-Shaper (Schematic #23111, PC Ass'y #19943)

Model 6316A, Top View



1 MHz Oscillator-Shaper Assembly

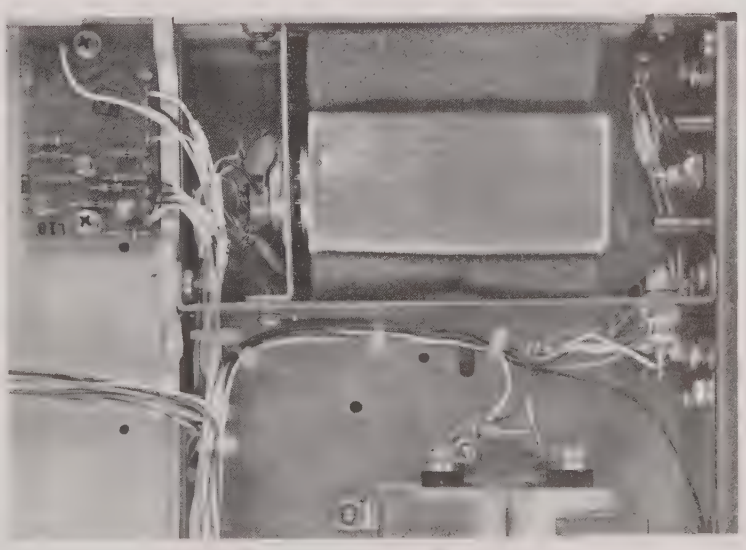


Figure 4-26. 1 MHz Oscillator-Shaper, Location

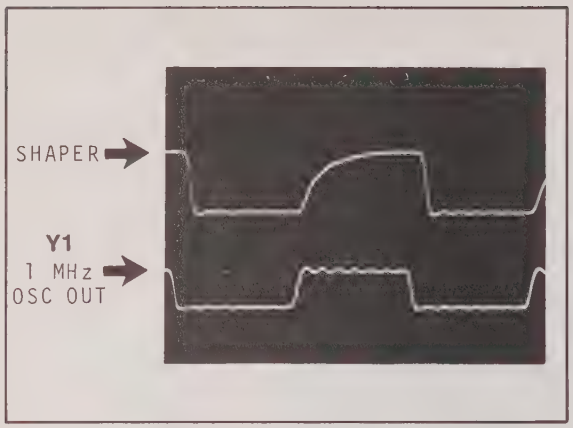


Figure 4-27.
1 MHz Oscillator-Shaper, Waveforms

The basic circuit consists of a plug-in 1 MHz oscillator module Y1, and a 1 MHz shaper circuit. Associated switching circuitry includes the rear panel EXT-INT switch, and the rear panel 1 MHz IN/OUT connector.

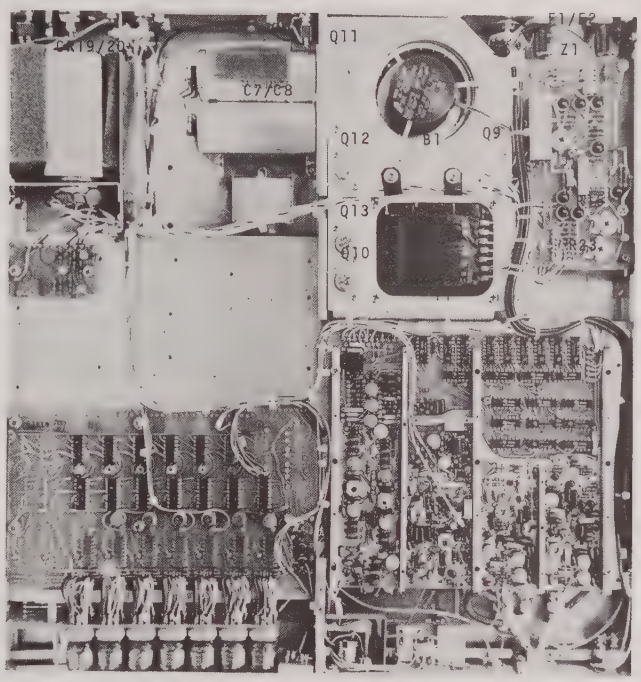
The square wave output of the oscillator Y1 (Figure 4-27 Upper Trace) is connected to one side of EXT-INT switch S8. The 1 MHz IN/OUT connector J4 is connected to the arm of S8, and to the input of the shaper circuit. In the INT position of S8, the 1 MHz output of Y1 is connected directly to the shaper circuit, and is also available as an output at J4. In the EXT position S8 disconnects Y1, leaving only the circuit to J4 connected. In this condition, an external frequence standard oscillator may be connected to J4 to provide the instrument's reference frequence.

The shaper circuit shapes the oscillator square wave for use throughout the instrument. It consists of two amplifier stages Q1 and Q2, and the shaper stage Q3. Its output is essentially as represented by the lower trace in Figure 4-26.

The specifications for this standard oscillator are included under instrument specifications in Chapter 1, Section 3.4. Data on optional high performance oscillators will be found in Chapter 7.

4.3.8 Power Supply (Schematic #19735, PC Ass'y #19938)

Model 6316A, Top View



Power Supply

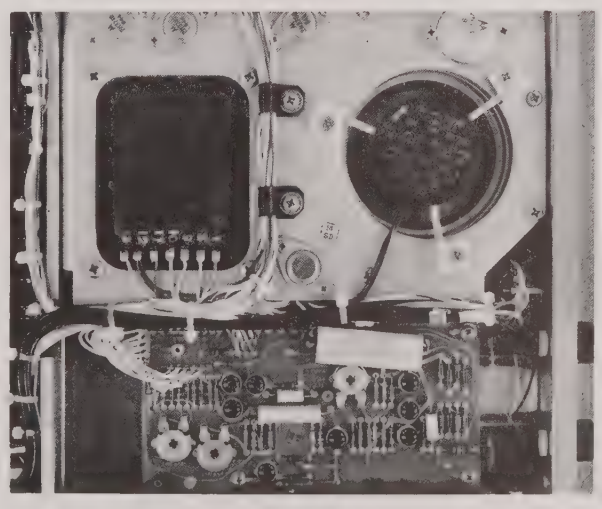


Figure 4-28. Power Supply, Location

The Power Supply circuit provides for control of the instrument's primary ac power, and supplies the voltages needed to operate all other circuits within the instrument.

The primary power circuit consists of line filter Z1, fuses F1 and F2, front panel POWER switch S1, rear panel Lane SELECTOR switch S6, and cooling fan motor B1. S6 provides switching of the primary circuits to operate from either 115V or 230V ac sources. Tie points x/x' and y/y' are utilized to provide controlled ac power for such functions as oscillator over heat. Tie points z/z' are used for connecting optional oven heat circuits for critical high stability oscillators whose ovens must remain on at all times, even though instrument power is turned off. Fan motor B1 runs and 115 vac power is applied to the primary windings of transformer T1 as long as POWER switch S1 is closed.

The +5 volt circuit consists of T1 windings 11-12-13, rectifier diodes CR19/20, filter capacitors C7/8, current regulators Q11/12, and regulation amplifier circuit Q7 and Q8. This circuit supplies +5 volts at 2 amperes with less than 100 mV ripple. It may be monitored at TP3 (orange) on the pc assembly, and its output adjusted using potentiometer R15.

The +15 volt circuit consists of T1 windings 9-6-10, bridge rectifier CR5/6/7/8, capacitor C2, current regulator Q9, and regulation amplifier circuit Q1/2/3. This circuit supplies +15 volts at 200 ma with 13ss than 100 mV ripple. It may be monitored at TP2 (red) on the pc assembly, and its output adjusted using potentiometer R7.

The -15 volt circuit utilizes the same T1 winding and bridge rectifier as the +15 volt supply, along with current regulator Q10, capacitor C3, and regulation amplifier Q4/5/6. This circuit supplies -15 volts at 150 ma with less than 100 mV ripple. It may be monitored at TP1 (brown) on the pc assembly, and its output adjusted using potentiometer R23.

The -5 volt circuit uses the output of the -15 volt supply through amplifier Q13 controlled by zener diode CR18. The circuit supplies -5 volts at 50 ma with less than 100 mV ripple. Its output is controlled by the operation of the -15 volt supply.

The +225 volt supply consists of T1 winding 7-8, bridge rectifier CR1/2/3/4, load resistor R26, and filter capacitor C1. This circuit supplied +225 volts at 30 ma with less than 200 mV ripple.

All components are mounted on the pc assembly except the power transistors, power transformer, rectifier diodes CR19/20, capacitors C7 and C8, the various switches, and the fuses and line filter. The location of these few components is indicated in Figure 4-27.

CHAPTER 5

MAINTENANCE AND REPAIR

5.1 INTRODUCTION

This chapter contains procedures for aligning and calibrating the instrument. It also contains a troubleshooting and repair section to aid your in maintaining the instrument in proper operating condition. The inclusion of this information, however, in no way abridges or modifies the terms and conditions of the equipment warranty as stated in the front of this manual.

The Model 6316A Frequency Meter makes use of circuits which require a fully equipped maintenance facility for proper service. Field repair of these circuits is not recommended, and a notation to this effect is included where necessary.

5.2 FACTORY SERVICE

Systron-Donner Corporation maintains a Service Department equipped and staffed for complete and economical service on all Systron-Donner instruments. Use of this service beyond the warranty period is recommended, to keep your instrument in "like new" condition. Please include the complete model and serial number in all correspondance regarding this instrument. Direct all inquiries, requests for service, etc. to: your nearest Sales/Service Representative, or:

Service Manager
Measurement Products Division
Systron-Donner Corporation
888 Galindo Street
Concord, California 94520
Telephone 415/682-6161
TWX 415/687-3200
Cable SYSTRONDONNER

5.3 TEST EQUIPMENT

The following table lists the minimum test equipment inventory capable of supporting the maintenance of the Model 6316A Frequency Meter. In the event these specific items are not available, units of equal or greater accuracy or capability may be used.

Table 5-1

Item	Name	Model
1	Digital Voltmeter	S-D 9000
2	100 MHz Oscilloscope	Tektronix Model 851
3	Dual Trace Plug-In	Tektronix Model 82
4	Signal Generator 10-480 MHz	Hewlett-Packard Model 608C
5	Signal Generator 10 GHz - 15.5 GHz	Hewlett-Packard Model 626A
6	Signal Generator 10 Hz - 10 MHz	Hewlett-Packard Model 651B

Standard Electronic tools and supplies suitable for solid state equipment maintenance.

5.4 CALIBRATION AND TEST PROCEDURES

Refer to related schematics and assembly drawings in Chapter 6 for aid in making the following tests:

5.4.1 AC and Power Supply (Use Item #1)

a) Disconnect the instrument from the power source and remove covers.

b) Turn front panel POWER switch to ON position.

c) Make the following resistance measurements.

Line to line of power cord 8Ω ±2Ω

Each line to chassis ground 15 MΩ -0Ω +"∞"Ω.

+225V buss to chassis ground 180 kΩ -0Ω +100 kΩ

+15V buss to chassis ground 500Ω -0Ω +1000Ω

-15V buss to chassis ground 400Ω -0Ω +500Ω

+5V buss to chassis ground 80Ω -0Ω +100Ω

-5V buss to chassis ground 180Ω -0Ω +200Ω

d) Connect the instrument to 117V rms ±3V rms 60 Hz power source.

> WARNING
>
> With the instrument covers removed and power on, power circuits are exposed which carry potentials considered dangerous to life.

e) Make the following voltage measurements and adjustments in the order given:

+15V (TP2) adjust to within ±0.1V

-15V (TP1) adjust to within ±0.1V

+5V (TP3) adjust to within ±0.5V

-5V (Terminal 6) no adjustment: should be within -0 +0.2V

+225 (+225V terminal) no adjustment: should be within 240V ±10V

f) Observe the supply busses for ripple (Use Item #2 & #3)

+5V (TP3) 120 Hz ripple less than 50 mV p-p

+15V (TP2) 120 Hz ripple less than 50 mV p-p

-15V (TP1) 120 Hz ripple less than 50 mV p-p

-5V (Terminal 6) 120 Hz ripple less than 50 mV p-p

+225V (+225V terminal) 120 Hz ripple less than 3V p-p

5.4.2 Oscillator and Shaper (Use Item 2 & 3)

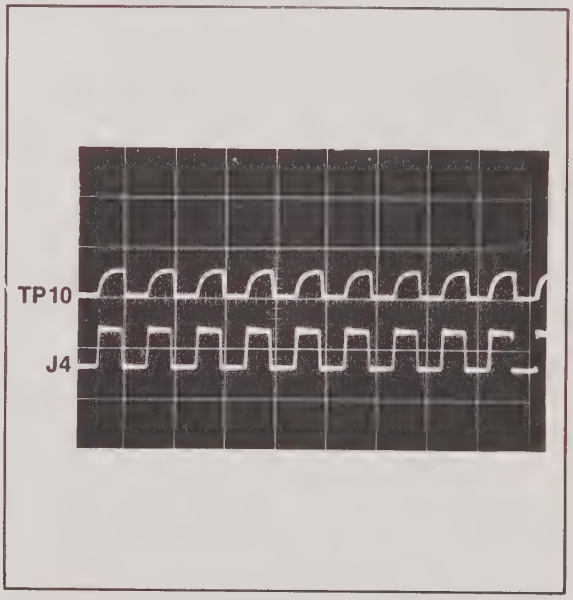


Figure 5-1. Oscillator and Shaper

a) Observe the 1 MHz signal at the 1 MHz INT/EXT connector. Signal amplitude should be 4.0V p-p -0 +0.5V p-p or less, depending on type oscillator.

> CAUTION
>
> Transformer slugs are graphite and easily broken.

b) Observe the shaped 1 MHz signal at Frequency Function Board TP10.

5.4.3 100 MHz Amplifier (Use Item #1)

a) Place the RANGE switch in the 0-.1 GHz range, and the LEVEL/SENSITIVITY control fully ccw in the PRESET detent.

b) With no signal applied, measure the voltage at terminal 9. Adjust R21 for a reading of .000V ±.005V.

5.4.4 0-.1 GHz Range (Use Item #4)

a) Place the RANGE switch in the 0-.1 GHz range, and the LEVEL/SENSITIVITY control fully ccw in the PRESET detent.

b) Connect the signal generator to the A-INPUT using a 50Ω termination. Set the generator to provide a 100 MHz signal at 100 mV rms.

c) Adjust R45 in 100 MHz AMP and DECADE ass'y as required for a stable readout. In some instances it may be necessary to change R54 to a different value to accomplish this.

d) Change the signal generator output to 100 MHz at 1V rms and check for stable readout.

e) Remove the input signal. Place the LEVEL/SENSITIVITY control fully ccw but not into preset. Move the STORAGE switch to off. When the count gate opens, move the RESOLUTION switch to REMOTE. This keeps the count gate "open" for the following checks.

✓ Rotate the LEVEL/SENSITIVITY control back and forth from full cw to fully ccw. Observe that the first indicator tube cycles sequentially from 0 through 9 as the control is rotated.

✓ Return LEVEL/SENSITIVITY control to PRESET. Connect the signal generator (Item #6) to the A-INPUT, and set it for 10 Hz at 100 mV rms. Again rotate the LEVEL/SENSITIVITY control and observe that the second indicator tube sequences.

✓ Repeat this test for the remaining digits, using a frequence one decade higher each time.

f) Place the STORAGE switch in the ON position. Set the RESOLUTION switch in any convenient position. Connect the signal generator (Item #4 to the A-INPUT connector using 50 termination, and set its output as follows and observe proper indication:

100 MHz at 100 mV rms
50 MHz at 80 mV rms
25 MHz at 80 mV rms
10 MHz at 80 mV rms

g) Replace the signal generator (Item #4) with a low frequency signal generator (Item #6) using the 50 termination. Set the generator output as follows and observe proper indication (all signals 80 mV rms)

1 MHz
100 kHz
1 kHz
100 Hz
10 Hz

5.4.5 .1-.3 GHz Range

a) Set the RANGE switch to the .1-.3 GHz position and the RESOLUTION switch as desired.

b) Measure the voltage (Use Item #1) at terminal #1 on the 300 MHz Prescaler assembly. Adjust R49 as required for a reading of 0.000V 0.01V.

c) Check the indicator tubes for 000000001 reading. If a 000000002 reading is present, readjust R49 for a "1" reading, but as close as possible to 0.0V.

d) Connect a signal generator (Item #4)

to the .1-.3 GHz input connector and set for 310 MHz at 150 mV rms. On the 300 MHz Prescaler board:

✓ Turn R21 to midrange, and R59 fully ccw.

✓ Return R59 slowly cw until instrument reads correctly.

✓ Reduce amplitude of generator signal gradually while adjusting R21 for maximum signal.

✓ Tune the signal generator over the full .1 to .3 GHz ranges with signal level at greater than 1V rms. If readings are erratic, readjust R59 ccw to correct.

Readings should be correct over the full range at signal levels between 80 mV and 2V.

5.4.6 .3-3 GHz and 3-12.4 GHz ACTO Ranges (Remove ACTO assembly cover, reinstall center cover screw). N Computer Test

a) Place RANGE switch in TEST position and the RESOLUTION switch in the 1k position. Remove the green wire from Terminal 13 and ground TP1 on the ACTO assembly. Verify a readout of 000.257000 GHz.

b) Connect the oscilloscope (Items #2 & 3) to TP3 on the ACTO assembly. Verify a positive 4 msec gate occuring once each counter recycle.

c) Replace the wire on terminal 13. Verify normal counter operation, 1 MHz Amplifier Adjustment.

d) Connect the oscilloscope (Items 2 & 3) to the collector of Q9 (of junction of C135/L31). Adjsut C58 for maximum amplitude of the 1 MHz signal. (4V p-p).

e) Check for presence of the 1 MHz signal at the collectors of Q7/Q8.

ACTO Local Oscillator Adjustments

f) Place the RANGE switch in the 3-12.4 GHz position, and the RESOLUTION switch in the 1M positon. Ground TP1 and TP2 on the ACTO assembly.

g) The counter will display the frequency of the high range (3-12.4 GHz) ACTO oscillator, multiplied by 257. Adjust L17 until the counter reads 000024.350 ±.01 GHz.

h) Change the RANGE switch to the .3-3 GHz position, and ground TP1 and TP2 on the ACTO Assembly.

i) The counter will display the frequency of the low range (.3-3 GHz) ACTO oscillator, multiplied by 257. Adjust L14 until the counter reads 000007.335 ±.01 GHz.

j) Remove the ground connections to TP1 and TP2. 1 kHz Amplifier and Phase Shigt Network.

k) Connect the oscilloscope (Items 2 & 3) to the collector of Q27. Verify a 1 kHz sinewave 1.75V ±0.25 V p-p

l) Connect the oscilloscope external triger to TP8 on the Frequency Function assembly.

m) Using dual trace, monitor the 1 kHz signals on the positive ends of C93 and C94. Verify equal amplitude DC level, and 90° phase difference. Repeat at C92 & C95.

n) Place RANGE switch in the 3-12.4 GHz position connect TP2 to the oscilloscope (Items 2 & 3) horizontal input, and ACTO assembly terminal 1 to the veritcal input (use short ground connection at the probe end). Adjust T9 for maximum amplitude and flatness of trace.

o) Place RANGE switch in the .3-3 GHz position, adjust T8 for maximum amplitude and flatness of trace.

p) Place the RANGE switch in the 3-12.4 GHz position, and the RESOLUTION switch to 1k. Rotate the LEVEL/SENSITIVITY control maximum ccw. Check that R5 and R23 are set maximum ccw.

q) Connect a signal generator (Item #5 to the 3.12.4 GHz input and set to 10.0 GHz at -13 dBm (50 mV rms). Connect the oscilloscope vertical input to TP1 on the ACTO assembly, and external trigger to TP8 on the Frequency Function assembly.

r) Slowly rotate the LEVEL/SENSITIVITY control cw until LOK light comes on to indicate that the ACTO has locked on the the input signal. Observe "1 kHz x N" signal on the oscilloscope. Adjust C112 for minimum phase modulation.

s) Rotate the LEVEL/SENSITIVITY control ccw. Remove 10 GHz signal generator input and replace with 300 MHz signal from Item 4 signal generator, at -15 dBm (40 mV rms).

t) Turn LEVEL/SENSITIVITY control cw until ACTO locks on to input signal (LOK light on). Observe the "1 kHz x N" signal on the oscilloscope. Adjust C100 for minimum phase modulation.

u) Replace signal generator with item #5. Tune slowly from 10.0 GHz to 12.4 GHz at -10 dBm. Varify that the ACTO tracks the input correctly.

Frequency Shifter Alignment

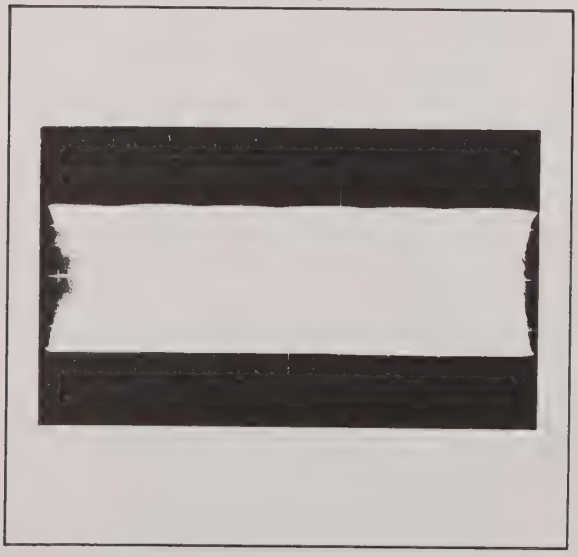


Figure 5-2. Freq. Shifter Wave Forms

NOTE

Figure 5-2 is a typical waveform as seen with the oscilloscope specified, amplitude 400 mV. An oscilloscope with greater frequency response will produce a trace higher amplitude.

5.4.7 Remove all test leads and replace ACTO cover. Place the RANGE switch to TEST and RECYCLE to . Push RESET button and observe that the counter recycles.

5.5 REPAIR PROCEDURES

modify per addendum

5.5.1 Preventive Maintenance

No special preventive maintenance procedures are required. Visually inspect for burned, cracked, or bulging components each time the instrument is serviced. Clean out any accumulated dust or dirt whenever the covers are removed. Check for loose printed circuit boards, or other components, and that the fan is free to rotate.

5.5.2 Printed Circuit Board Repair

To replace a part on a printed-circuit board, cut the leads of the part near the lead holes. Using low-power (50-watt or less) soldering iron, apply heat sparingly to the cut lead. As soon as the solder melts, slip the lead from the hole and clean the hole with a toothpick. Clean the board surfaces with isopropyl alcohl. Form the tinned leads of the replacement part and insert in the cleaned holes, trimming leads to extend 1/16-inch beyond the back surface of the board Use only 63-37 solder with maximum diameter of 1/16-inch. Solder the leads to the board and use a hemostat, long-

nosed pliers or other type of heat sink on the leads of all semiconductor devices and 1/4 watt resistors. Allow the soldered junction to cool before removing the heat sink.

5.5.3 Troubleshooting Procedures

The following information is included as a guide only, and is not intended as a definitive indication of causes of a malfunction.

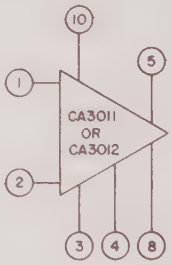
Table 5-2

Trouble Indication	Possible Cause
1. No indicators light or all are fuzzy	a. Check Power Supply
2. Erratic readout with no input	a. Rectifier diodes open on PC ass'y.
3. No Auto Recycle	a. Q2 or associated circuitry on Frequency Function ass'y defective.
4. No TIME BASE OUT	a. Check for 1 MHz out rear connection and at TP10 on Frequency Function Assembly. b. Check that each decade ÷10 (IC14-IC20 on Frequency Function Assembly.
5. No Time Base in Prescaler or ACTO ranges.	a. Defective Binary (IC1-IC8) in "N" computer.
6. Double or Fuzzy numbers in one indicator	a. Defective driver. (IC1-IC22) on readout PC Assembly.
7. Low Sensitivity	ACTO Range a. ACTO mixer diodes defective b. Power splitter attenuating input 0-.1 GHz Range c. Input amplifier defective .1-.3 Range d. Prescaler out of adjustment
8. Erratic or Random Readout	ACTO Range a. Mixer cable grounds not properly soldered. b. Defective mixer diodes in "N" mixer. c. Loose Allen screws on mixer BNC probes. d. Q28 on ACTO assembly defective. e. 1 MHz Added out of alignment. .1-.3 Range f. Prescaler out of alignment defective. g. Prescaler CR5/6 defective.
9. Incorrect Count	a. Check that 100 MHz A & D Assembly is ÷10. b. Then check that each decade (IC6-IC24 on readout ass'y) ÷10.

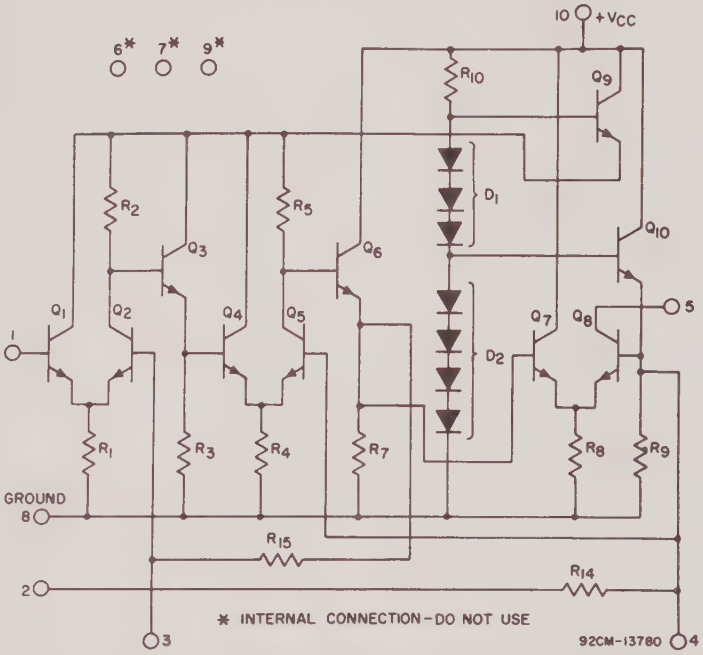
Table 5-2 (con't.)

Trouble Indication	Possible Cause
10. Frequency "Holes"	a. Mixer or H.G. diode in LOK mixer.
11. ACTO "LOKS" 2 MHz low	a. Decrease value of R27 or C56 on ACTO.

CA3011
CA3012
Wide-Band Amplifiers



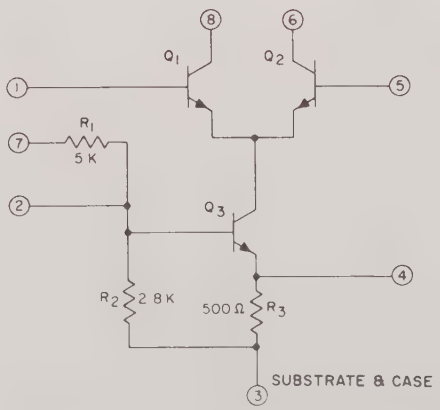
SCHEMATIC DIAGRAM FOR CA3011 AND CA3012



CA3028A
CA3028B
Differential/Cascode Amplifiers

The CA3028A and CA3028B are differential/cascode amplifiers designed for use in communications and industrial equipment operating at frequencies from dc to 120 MHz.

The CA3028B is like the CA3028A but is capable of premium performance particularly in critical dc and differential amplifier applications requiring tight controls for input offset voltage, input offset current, and input bias current.



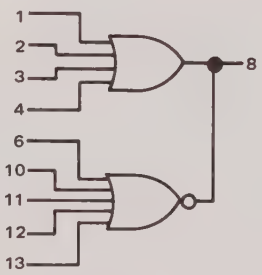
Schematic diagram for CA3028A

MECL-TO-SATURATED LOGIC
TRANSLATORS

MC1018
MC1218

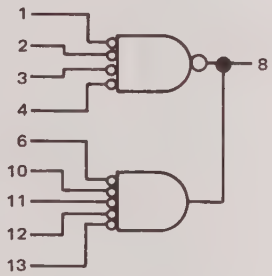
Level translator intended for converting MECL signal levels to saturated logic levels. The translator will provide the positive logic OR or logic NOR function by connecting the internal bias driver output to the corresponding inputs of the differential amplifier. i.e., when pin 4 is connected to the reference bias, pin 5, pins 6, 10, 11 12, and 13 become the inputs of a 5-input NOR gate. When pin 6 is connected to the reference bias, pin 5, pins 1, 2, 3, and 4 become the inputs of a 4-input OR gate.

POSITIVE LOGIC



$8 = 1+2+3+4$
or
$8 = \overline{6+10+11+12+13}$

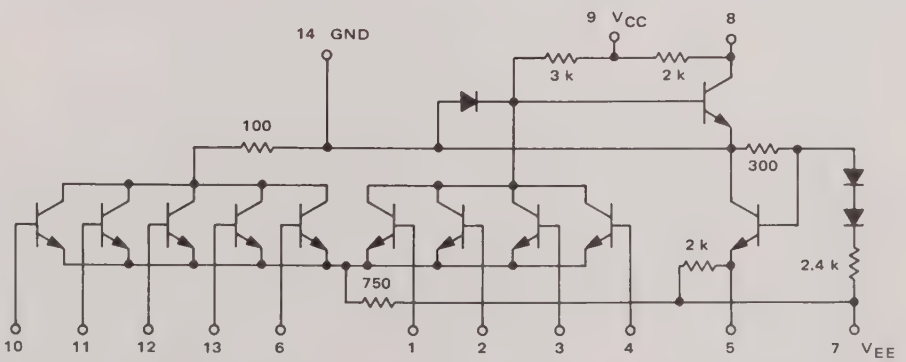
NEGATIVE LOGIC



$8 = \overline{1} \bullet \overline{2} \bullet \overline{3} \bullet \overline{4}$
or
$8 = \overline{6 \bullet 10 \bullet 11 \bullet 12}$

DC Input Loading Factor = 2 (MECL)
DC Output Loading Factor = 7 (DTL)
Power Dissipation = 55 mW typical

CIRCUIT SCHEMATIC



Resistor values are nominal.

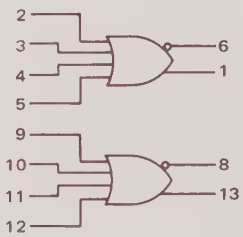
DUAL 4-INPUT
CLOCK DRIVER

MC1023

Provides simultaneous OR/NOR or AND/NAND output functions. It contains an internal bias reference insuring that the threshold point is always in the center of the transition region over the temperature range.

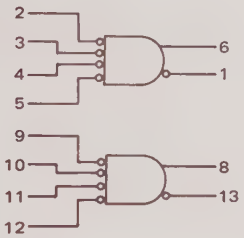
This circuit is designed to operate in high-speed digital computer applications as a clock driver or as a high-speed gate.

POSITIVE LOGIC



$6 = \overline{2 + 2 + 4 + 5}$
$1 = 2 + 3 + 4 + 5$

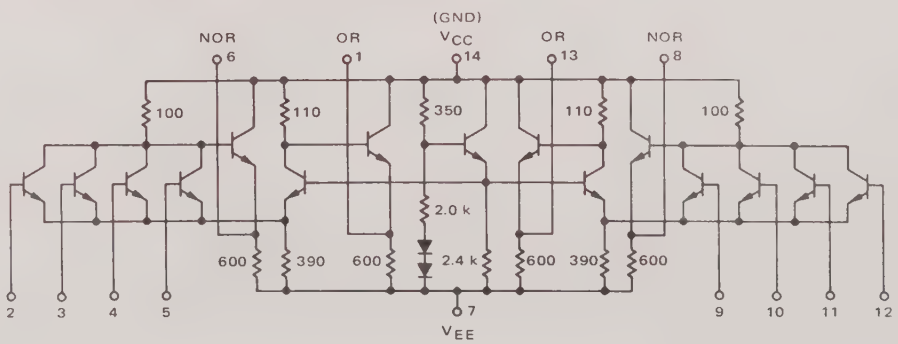
NEGATIVE LOGIC



$6 = \overline{2 \bullet 3 \bullet 4 \bullet 5}$
$1 = 2 \bullet 3 \bullet 4 \bullet 5$

DC Input Loading Factor = 3
DC Output Loading Factor = 25
Power Dissipation = 250 mW typical

CIRCUIT SCHEMATIC



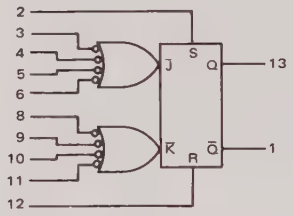
Resistor values are nominal.

120-MHz AC-COUPLED
J-K FLIP FLOPS

MC1027

Designed for use at clock frequencies to 100 MHz minimum (120 MHz typical). Logic performing inputs ($\overline{J}$ and $\overline{K}$) are available, as well as dc SET and RESET inputs.

POSITIVE LOGIC



DC Input Loading Factor = 2
DC Output Loading Factor = 25
Power Dissipation = 250 mW typical

R-S TRUTH TABLE

Pin No.	R	S	Q^{n+1}
	12	2	13
	0	0	Q^n
	0	1	1
	1	0	0
	1	1	N.D.

All $\overline{J}$-$\overline{K}$ Inputs Are Static

$\overline{J}_D$-$\overline{K}_D$ TRUTH TABLE

Pin No.	$\overline{J}_D$	$\overline{K}_D$	Q^{n+1}
	•	•	13
	0	0	Q^n
	0	1	0
	1	0	1
	1	1	$\overline{Q}^n$

All Other $\overline{J}$-$\overline{K}$ Inputs And The R-S Inputs Are At a "0" Level

CLOCKED $\overline{J}$-$\overline{K}$ TRUTH TABLE

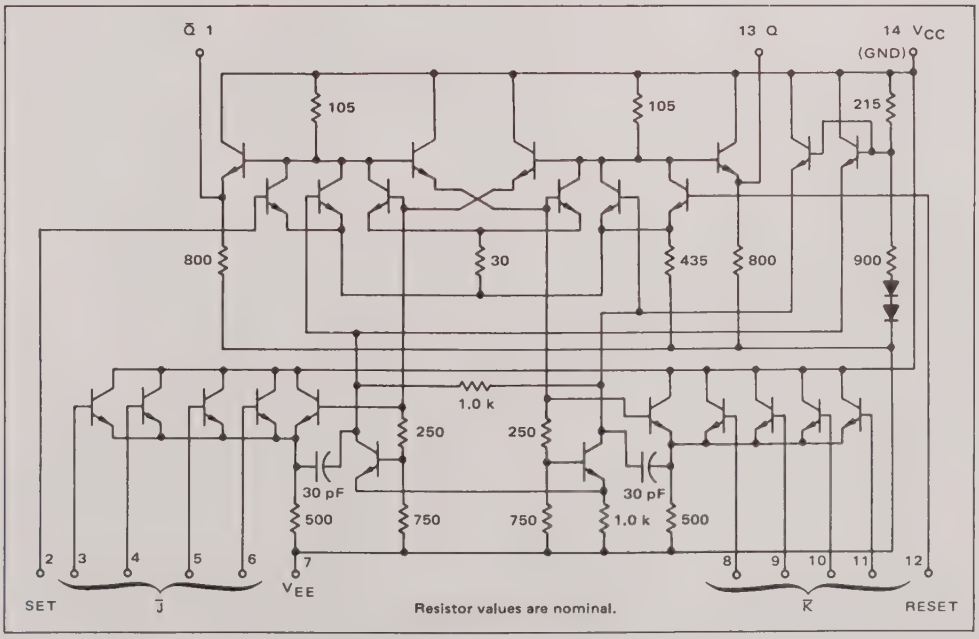
Pin No.	$\overline{J}$	$\overline{K}$	$\overline{C}_D$	Q^n
	•	•	••	13
	ϕ	ϕ	0	Q^n
	0	0	1	$\overline{Q}^n$
	0	1	1	1
	1	0	1	0
	1	1	1	Q^n

All Other $\overline{J}$-$\overline{K}$ Inputs And The R-S Inputs Are At a "0" Level

* Any $\overline{J}$ or $\overline{K}$ Input, not used for $\overline{C}_D$.
** $\overline{C}_D$ obtained by connecting one $\overline{J}$ and one $\overline{K}$ input together.

The $\overline{J}$ and $\overline{K}$ inputs refer to logic levels while the $\overline{C}_D$ input refers to dynamic logic swings. The $\overline{J}$ and $\overline{K}$ inputs should be changed to a logical "1" only while the $\overline{C}_D$ input is in a logic "1" state. ($\overline{C}_D$ maximum "1" level = V_{CC} −0.6 V). Clock $\overline{C}_D$ is obtained by tying one $\overline{J}$ and one $\overline{K}$ input together.

CIRCUIT SCHEMATIC



Resistor values are nominal.

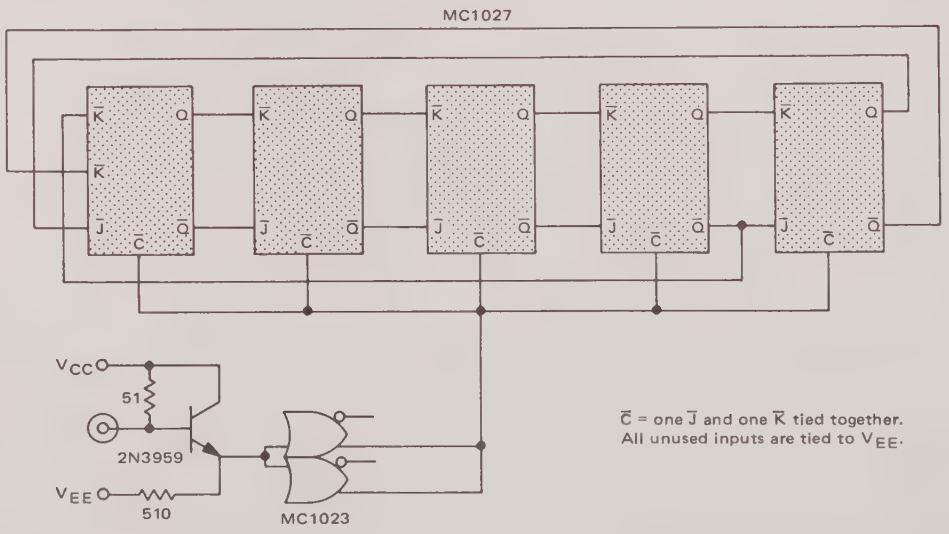
APPLICATIONS INFORMATION

The MC1027 flip-flop is obtained by reducing all resistor values of the MC1013 by a factor of two. The resultant flip-flop is no longer limited by circuit design, but by device speeds. Typically the MC1027 will operate 50% faster than the MC1013. Power dissipation is doubled over that of the MC1013, but circuit operation is the same. The MC1023 clock driver is recommended for driving the MC1027 to its full capability. (The MC1023 high-speed clock driver exhibits propagation delay and rise times of about 2.0 ns when driving five flip-flops.) Maximum operating frequency depends upon layout techniques. Short lead lengths with low impedance lines are recommended. A 100+MHz shift counter is shown in Figure 5.

Operation of the MC1027 is very uniform with negligible variation observed with temperature change from 0°C to +75°C. Propagation delay is nominally 4.5 ns, with rise and fall times varying from 3.5 to 4.0 ns with a load of another flip-flop on the output.

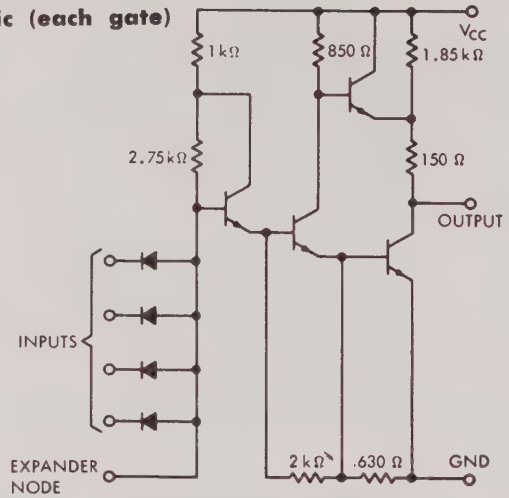
FIGURE 5 - 100 + MHz "SWITCH-TAIL" RING COUNTER

Shift pattern of five "0"s and five "1"s is assured by logic feedback from the fourth to first stage.

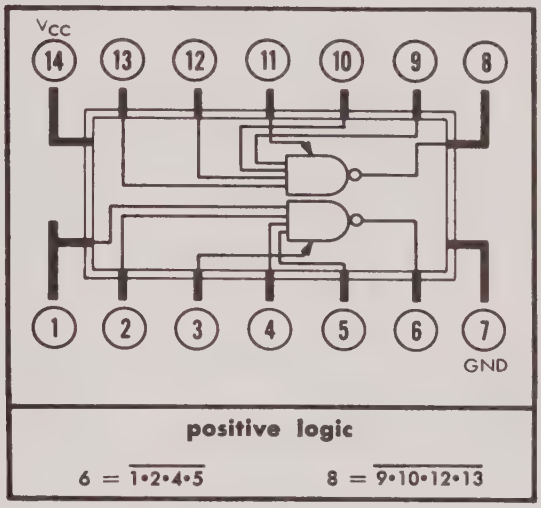


TYPE SN15 832
DUAL 4-INPUT NAND/NOR BUFFER

schematic (each gate)

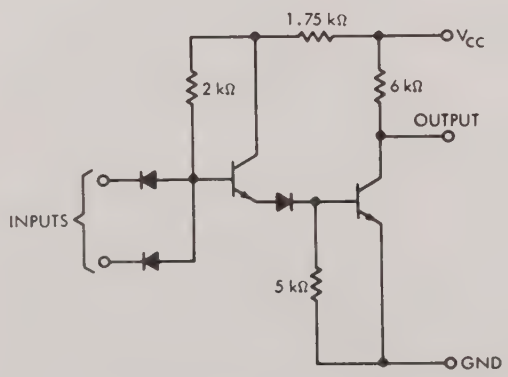


Component values shown are nominal.

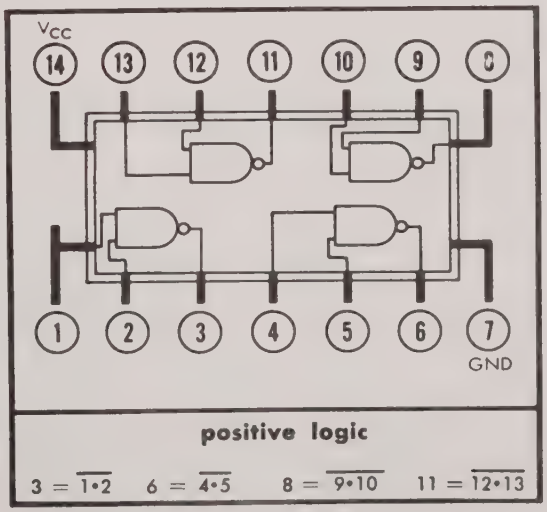


TYPE SN15 846
QUADRUPLE 2-INPUT NAND/NOR GATE

schematic (each gate)

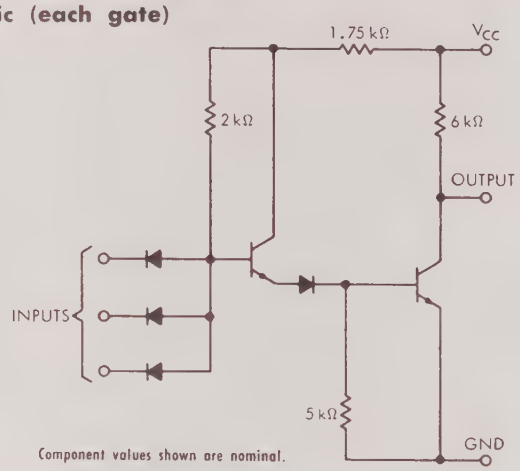


Component values shown are nominal.

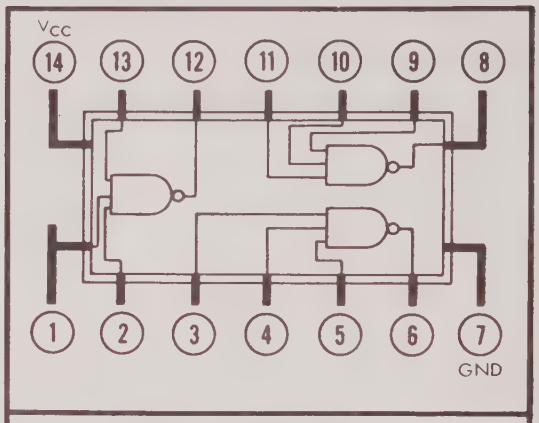


TYPE SN15 962
TRIPLE 3-INPUT NAND/NOR GATE

schematic (each gate)



Component values shown are nominal.

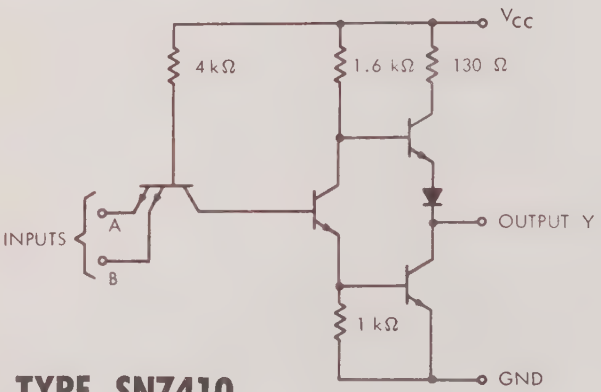


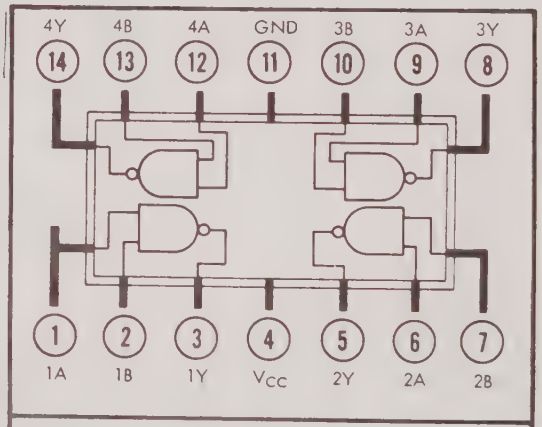
positive logic

$6 = \overline{3 \cdot 4 \cdot 5}$ $8 = \overline{9 \cdot 10 \cdot 11}$ $12 = \overline{1 \cdot 2 \cdot 13}$

TYPE SN7400
QUADRUPLE 2-INPUT POSITIVE NAND GATE

schematic (each gate)



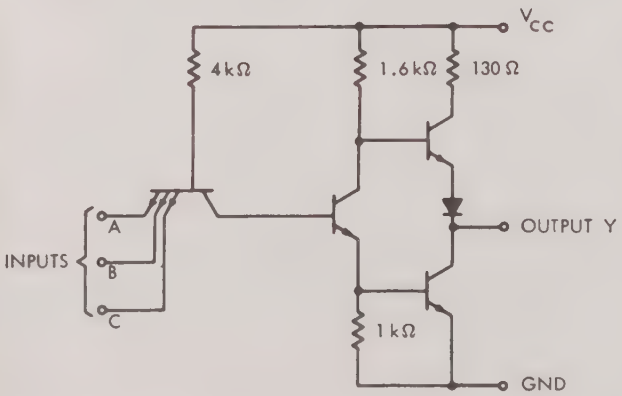


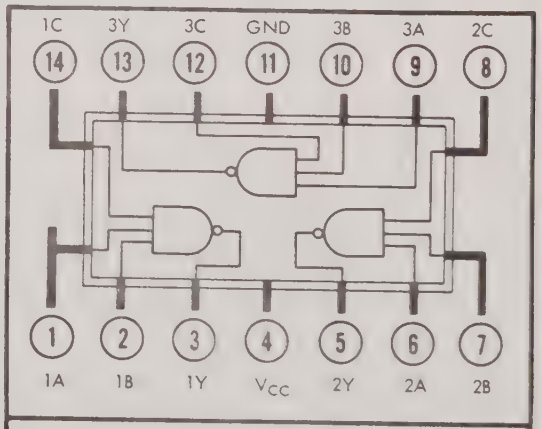
positive logic

$Y = \overline{AB}$

TYPE SN7410
TRIPLE 3-INPUT POSITIVE NAND GATE

schematic (each gate)





positive logic

$Y = \overline{ABC}$

CIRCUIT TYPE SN7441A
BCD-TO-DECIMAL DECODER/DRIVER

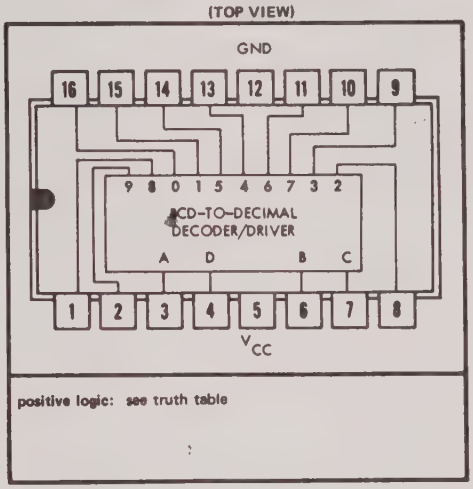
logic

TRUTH TABLE

INPUT				OUTPUT ON‡
D	C	B	A	
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	0	0	0	8
1	0	0	1	9

‡ All other outputs are off.

J OR N DUAL-IN-LINE PACKAGE
(TOP VIEW)



positive logic: see truth table

description

The SN7441A is a monolithic, BCD-to-decimal decoder incorporating high performance output transistors designed for driving gas-filled, cold-cathode indicator tubes. The BCD-to-decimal decoder consists of familiar transistor-transistor-logic (TTL) gate circuits which select one of the ten decimal output drivers. The BCD inputs are fully compatible with Series 74 logic outputs; and, in addition, physical placement of these inputs is coincidental with the BCD output of the SN7490 decade counter. The ten high-breakdown, n-p-n transistors have a maximum reverse current of 50 μA at 55 V over the operating temperature range.

A typical application shows the SN7441A used as a gas-filled, display-indicator driver.

typical application data

The SN7441A output transistors are capable of withstanding voltages and sinking current required to operate most types of gas-filled indicator tubes.

Clamping diodes have been incorporated in the outputs of this improved decoder/driver.

When these decoder/drivers are used in close proximity (on the same circuit board) with standard digital integrated circuits, care should be exercised to ensure that the impedance of the ground bus (including interconnections) is sufficiently low to absorb the normal energy levels resulting from switching the tube elements.

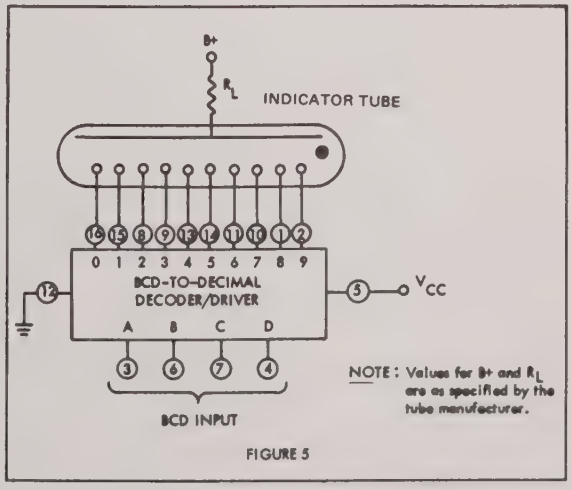


FIGURE 5

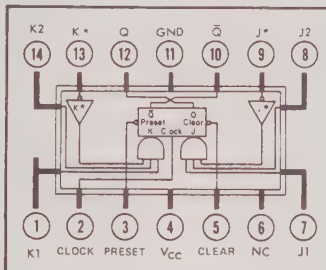
CIRCUIT TYPES SN5470, SN7470
EDGE-TRIGGERED J-K FLIP-FLOPS

logic

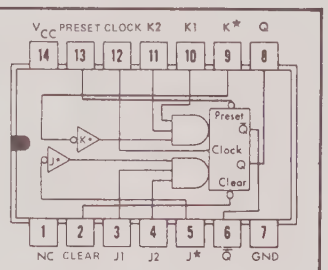
TRUTH TABLE		
t_n		t_{n+1}
J	K	Q
0	0	Q_n
0	1	0
1	0	1
1	1	$\overline{Q}_n$

NOTES:
1. $J = J1 \cdot J2 \cdot \overline{J^*}$.
2. $K = K1 \cdot K2 \cdot \overline{K^*}$.
3. t_n = Bit time before clock pulse.
4. t_{n+1} = Bit time after clock pulse.
5. If inputs J* or K* are not used they must be grounded.
6. NC - No Internal Connection

S FLAT PACKAGE
(TOP VIEW)



J OR N DUAL-IN-LINE PACKAGE
(TOP VIEW)



positive logic: Low input to preset sets Q to logical 1
Low input to clear sets Q to logical 0
Preset or clear function can occur only when clock input is low.

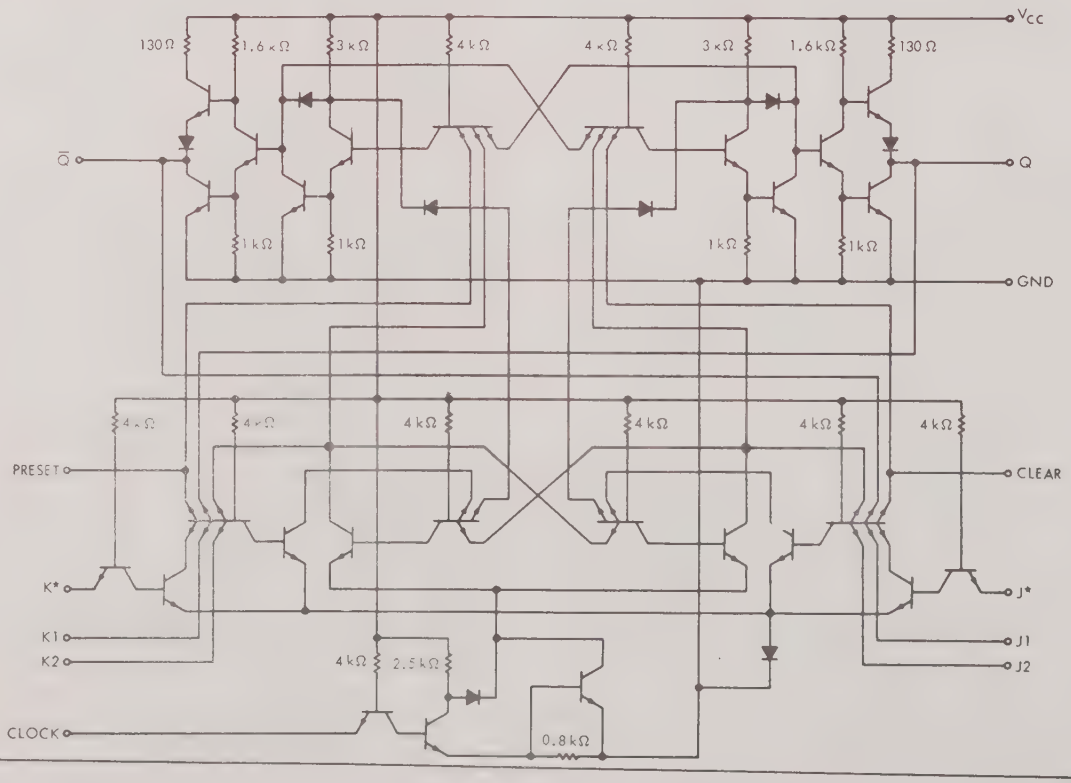
description

These monolithic, edge-triggered J-K flip-flops feature gated inputs, direct clear and preset inputs, and complementary Q and $\overline{Q}$ outputs. Input information is transferred to the outputs on the positive edge of the clock pulse.

Direct-coupled clock triggering occurs at a specific voltage level of the clock pulse, and after the clock input threshold voltage has been passed, the gated inputs are locked out.

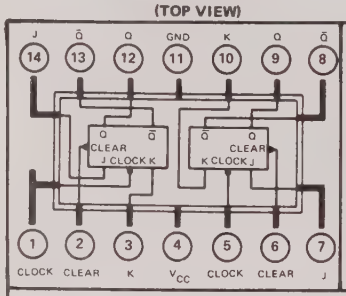
These flip-flops are ideally suited for medium- to high-speed applications and can result in a significant saving in system power dissipation and package count where input gating is required.

schematic

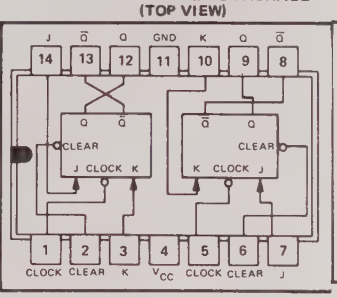


CIRCUIT TYPES SN5473
DUAL J-K MASTER-SLAVE FLIP-FLOPS

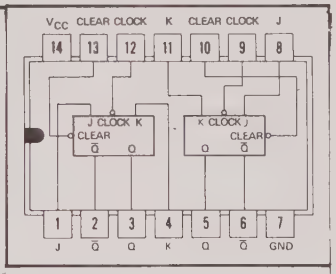
SN5473, SN7473
S FLAT PACKAGE
(TOP VIEW)



SN5473, SN7473
J OR N DUAL-IN-LINE PACKAGE
(TOP VIEW)



SN54107, SN74107
J OR N DUAL-IN-LINE PACKAGE
(TOP VIEW)



positive logic: Low input to clear sets Q to logical 0.
Clear is independent of clock.

description

These J-K flip-flops are based on the master-slave principle. Inputs to the master section are controlled by the clock pulse. The clock pulse also regulates the state of the coupling transistors which connect the master and slave sections. The sequence of operation is as follows: (See waveform on page 2-26)

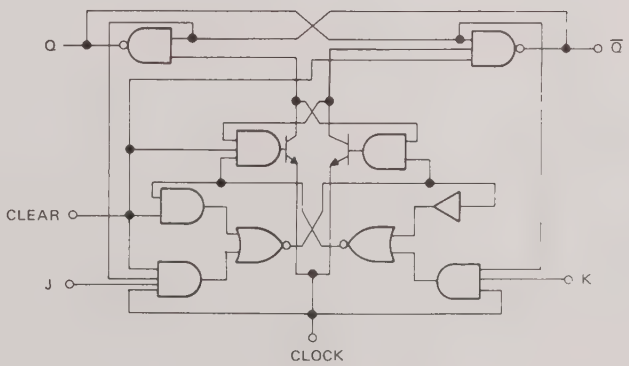
1. Isolate slave from master
2. Enter information from J and K inputs to master
3. Disable J and K inputs
4. Transfer information from master to slave.

logic

TRUTH TABLE (Each Flip-Flop)		
t_n		t_{n+1}
J	K	Q
0	0	Q_n
0	1	0
1	0	1
1	1	$\bar{Q}_n$

NOTES: 1. t_n = Bit time before clock pulse.
2. t_{n+1} = Bit time after clock pulse.

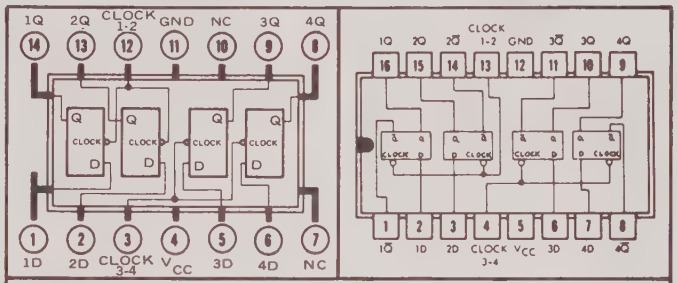
functional block diagram (each flip-flop)



CIRCUIT TYPES SN5475, 4-BIT BISTABLE LATCHES

SN5477/SN7477
S FLAT PACKAGE
(TOP VIEW)

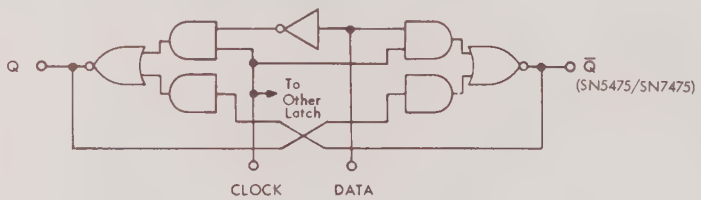
SN5475/SN7475
J OR N DUAL-IN-LINE PACKAGE
(TOP VIEW)


1Q 2Q CLOCK 1-2 GND NC 3Q 4Q
14 13 12 11 10 9 8
1D 2D CLOCK 3-4 VCC 3D 4D NC
1 2 3 4 5 6 7
CLOCK 1-2 GND 3Q 4Q
16 15 14 13 12 11 10 9
1 2 3 4 5 6 7 8
CLOCK 3-4 VCC 3Q 4Q
positive logic: see truth table

logic

TRUTH TABLE (Each Latch)	
t_n	t_{n+1}
D	Q
1	1
0	0

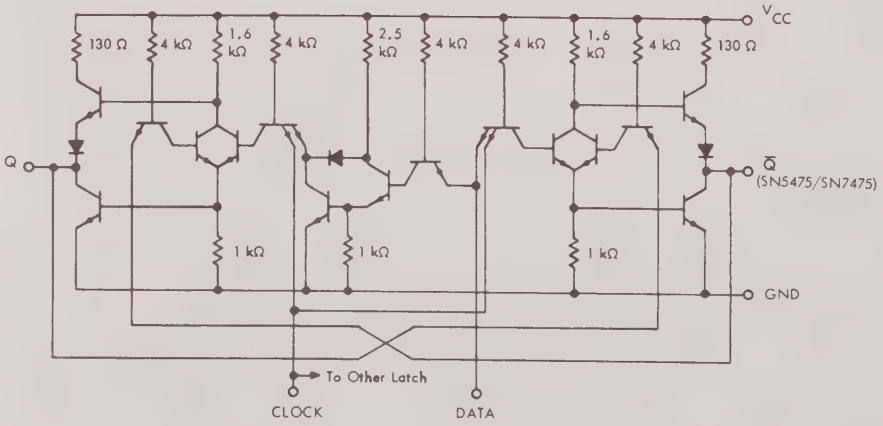
functional block diagram (each latch)



description

These latches are ideally suited for use as temporary storage for binary information between processing units and input/output or indicator units. Information present at a data (D) input is transferred to the Q output when the clock is high, and the Q output will follow the data input as long as the clock remains high. When the clock goes low, the information (that was present at the data input at the time the transition occurred) is retained at the Q output until the clock is permitted to go high.

schematic (each latch)



CIRCUIT TYPES SN5490, SN7490
DECADE COUNTERS

TRUTH TABLES

BCD COUNT SEQUENCE
(See Note 1)

COUNT	OUTPUT			
	D	C	B	A
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

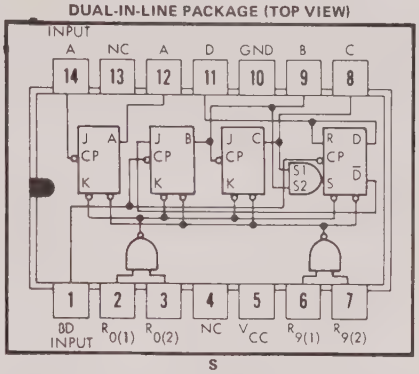
RESET/COUNT (See Note 2)

RESET INPUTS				OUTPUT
$R_{0(1)}$	$R_{0(2)}$	$R_{9(1)}$	$R_{9(2)}$	D C B A
1	1	0	X	0 0 0 0
1	1	X	0	0 0 0 0
X	X	1	1	1 0 0 1
X	0	X	0	COUNT
0	X	0	X	COUNT
0	X	X	0	COUNT
X	0	0	X	COUNT

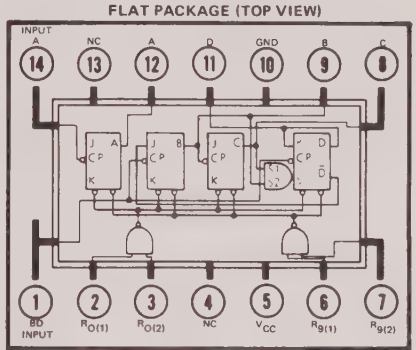
NC—No Internal Connection

NOTES: 1. Output A connected to input BD for BCD count.
2. X indicates that either a logical 1 or a logical 0 may be present.

J OR N
DUAL-IN-LINE PACKAGE (TOP VIEW)



W
FLAT PACKAGE (TOP VIEW)



positive logic: see truth table

description and typical count configurations

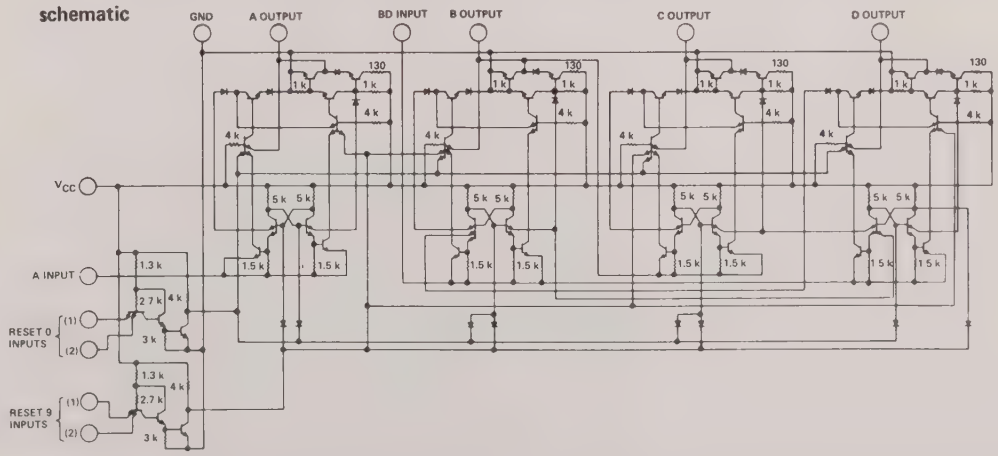
These high-speed, monolithic decade counters consist of four dual-rank, master-slave flip-flops internally interconnected to provide a divide-by-two counter and a divide-by-five counter. Gated direct reset lines are provided to inhibit count inputs and return all outputs to logical zero or to a binary coded decimal (BCD) count of 9. As the output from flip-flop A is not internally connected to the succeeding stages, the count may be separated in three independent count modes:

1. When used as a binary coded decimal decade counter, the BD input must be externally connected to the A output. The A input receives the incoming count, and a count sequence is obtained in accordance with the BCD count sequence truth table shown above. In addition to a conventional zero reset, inputs are provided to reset a BCD count for nine's complement decimal applications.

2. If a symmetrical divide-by-ten count is desired for frequency synthesizers or other applications requiring division of a binary count by a power of ten, the D output must be externally connected to the A input. The input count is then applied at the BD input and a divide-by-ten square wave is obtained at output A.

3. For operation as a divide-by-two counter and a divide-by-five counter, no external interconnections are required. Flip-flop A is used as a binary element for the divide-by-two function. The BD input is used to obtain binary divide-by-five operation at the B, C, and D outputs. In this mode, the two counters operate independently; however, all four flip-flops are reset simultaneously.

schematic



CHAPTER 6

DRAWINGS AND PARTS LISTS

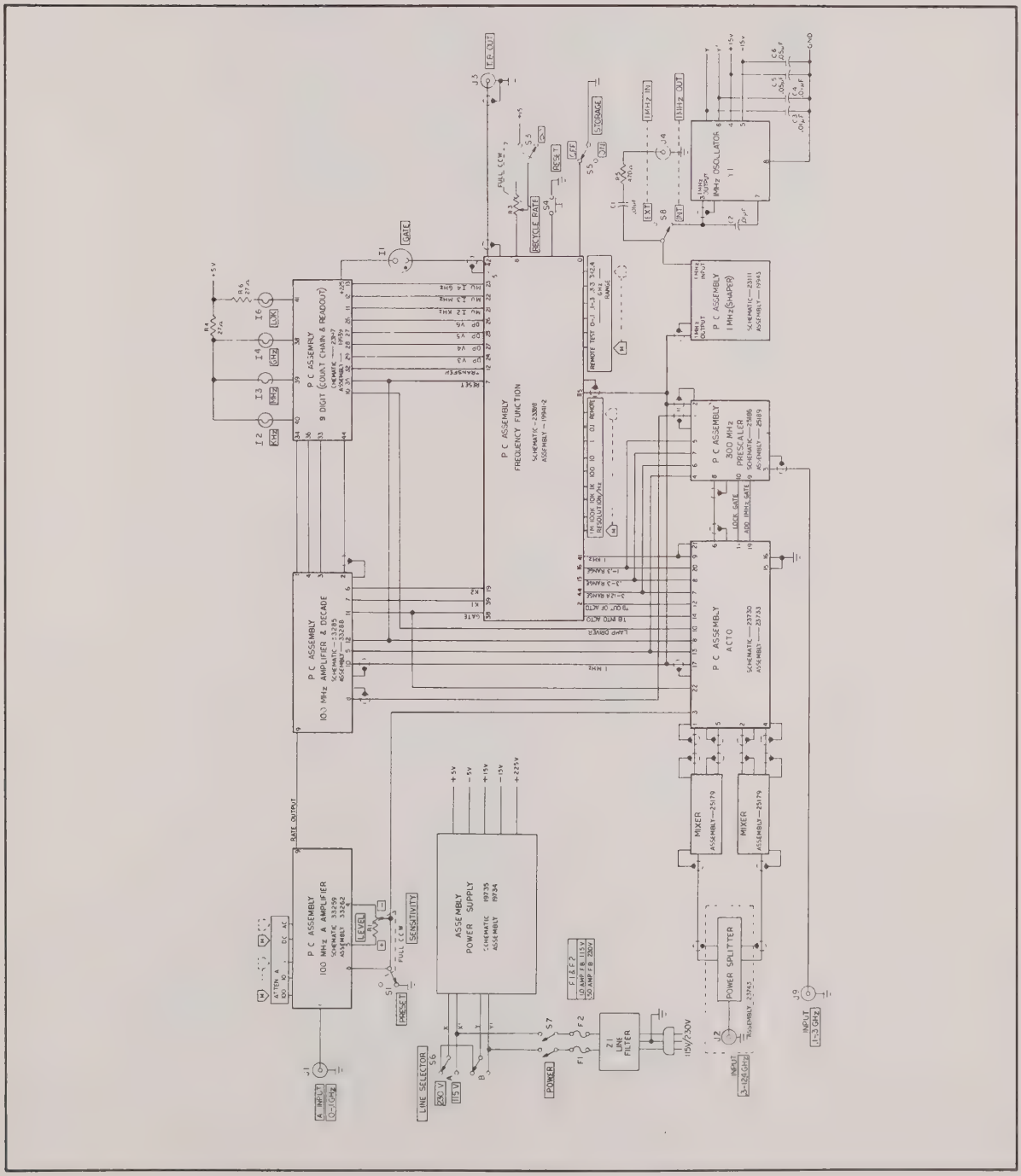
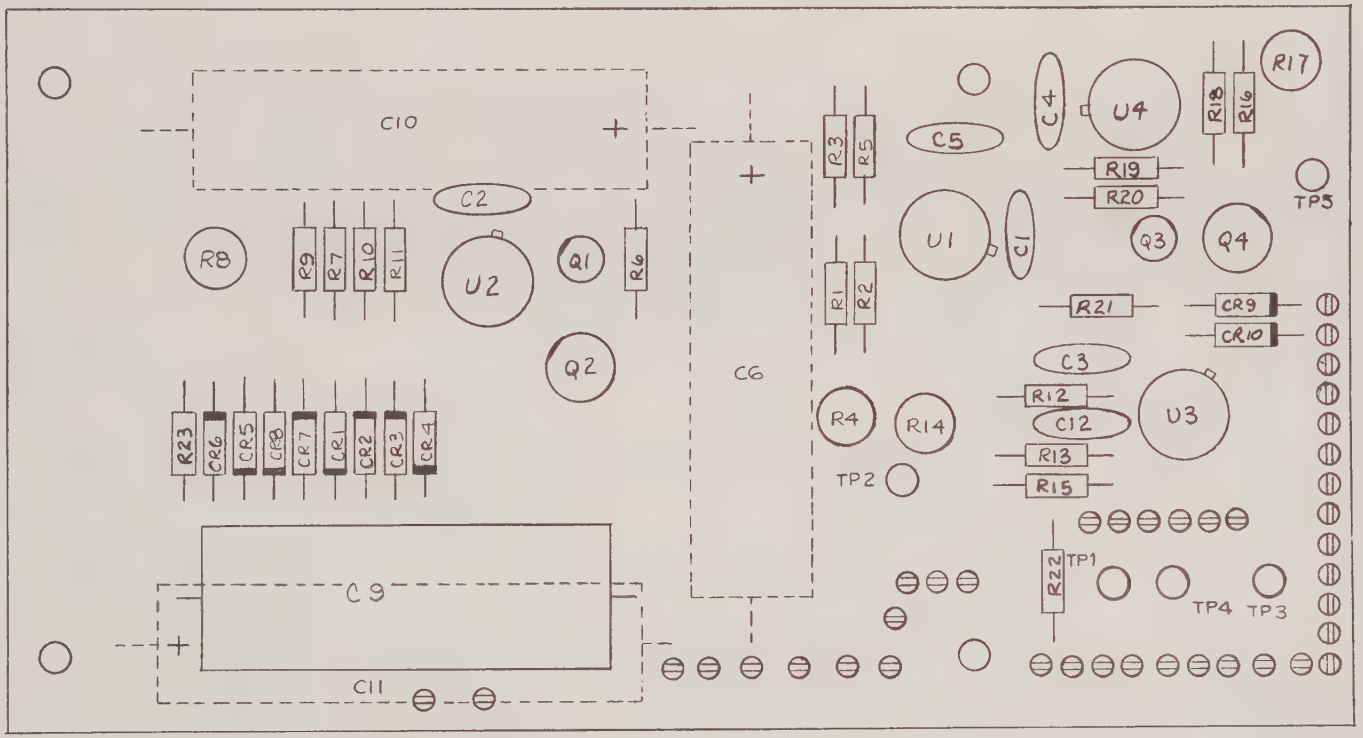
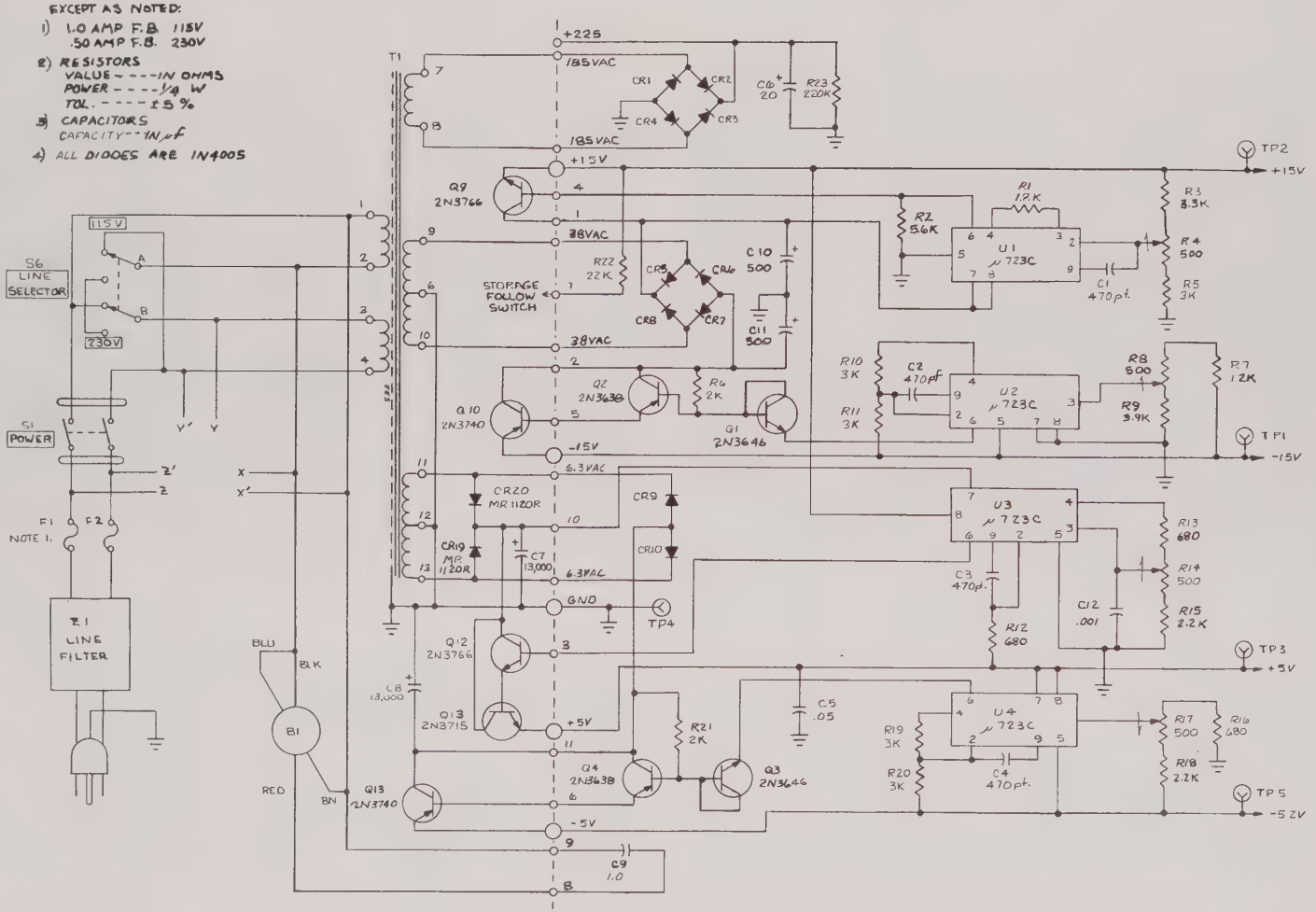


Figure 6-1. Block Diagram Model 6316A [25580D]



6000 SERIES POWER SUPPLY P.C. ASSEMBLY, D39467A



6000 SERIES POWER SUPPLY P.C. ASSEMBLY, C19735E

6000 SERIES POWER SUPPLY P.C. ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.	Manufacturers Part No.
	Power Supply P.C. Assembly	D39467A	
	Power Supply Schematic	C19735E	
C1	Capacitor, 470pF, 300V	C0542	
C2	Capacitor, 470pF, 300V	C0542	
C3	Capacitor, 470pF, 300V	C0542	
C4	Capacitor, 470pF, 300V	C0542	
C5	Capacitor, .05µF, 12V	C0672	RMC Type M-12
C6	Capacitor, 20µF, 350V	C1094	Sprague 39D206F350FL4
C7	Not Used		
C8	Not Used		
C9	Capacitor, 1µF, 400V	C0724	
C10	Capacitor, 500µF, 30V	C1134	Sprague 39K507GD30FL4
C11	Capacitor, 500µF, 30V	C1134	Sprague 39K507GD30FL4
C12	Capacitor, .001µF, 1000V	C0235	Centralab DD102
CR1	Diode, 1N4005	CR0284	
CR2	Diode, 1N4005	CR0284	
CR3	Diode, 1N4005	CR0284	
CR4	Diode, 1N4005	CR0284	
CR5	Diode, 1N4005	CR0284	
CR6	Diode, 1N4005	CR0284	
CR7	Diode, 1N4005	CR0284	
CR8	Diode, 1N4005	CR0284	
CR9	Diode, 1N4005	CR0284	
CR10	Diode, 1N4005	CR0284	
Q1	Transistor, 2N3646	Q0218	
Q2	Transistor, 2N3638	Q0181	
Q3	Transistor, 2N3646	Q0218	
Q4	Transistor, 2N3638	Q0181	
R1	Resistor, 1.8K, 1/4W, 5%	R0959	A-B 1.8K, 1/4W, 5%
R2	Resistor, 5.6K, 1/4W, 5%	R0821	A-B 5.6K, 1/4W, 5%
R3	Resistor, 3.3K, 1/4W, 5%	R0742	A-B 3.3K, 1/4W, 5%
R4	Resistor, 500Ω, Pot	R2375	CTS 340
R5	Resistor, 3K, 1/4W, 5%	R0711	A-B 3K, 1/4W, 5%

Ref.	Description	SD Part No.	Manufacturers Part No.
R6	Resistor, 2K, 1/4W, 5%	R0734	A-B 2K, 1/4W, 5%
R7	Resistor, 1.2K, 1/4W, 5%	R0809	A-B 1.2K, 1/4W, 5%
R8	Resistor, 500Ω, Pot	R2375	CTS 340
R9	Resistor, 3.9K, 1/4W, 5%	R0939	A-B 3.9K, 1/4W, 5%
R10	Resistor, 3K, 1/4W, 5%	R0711	A-B 3K, 1/4W, 5%
R11	Resistor, 3K, 1/4W, 5%	R0711	A-B 3K, 1/4W, 5%
R12	Resistor, 680Ω, 1/4W, 5%	R1234	A-B 680Ω, 1/4W, 5%
R13	Resistor, 680Ω, 1/4W, 5%	R1234	A-B 680Ω, 1/4W, 5%
R14	Resistor, 500Ω, Pot	R2375	CTS 340
R15	Resistor, 2.2K, 1/4W, 5%	R0749	A-B 2.2K, 1/4W, 5%
R16	Resistor, 680Ω, 1/4W, 5%	R1234	A-B 680Ω, 1/4W, 5%
R17	Resistor, 500Ω, Pot	R2375	CTS 340
R18	Resistor, 2.2K, 1/4W, 5%	R0749	A-B 2.2K, 1/4W, 5%
R19	Resistor, 3K, 1/4W, 5%	R0711	A-B 3K, 1/4W, 5%
R20	Resistor, 3K, 1/4W, 5%	R0711	A-B 3K, 1/4W, 5%
R21	Resistor, 1K, 1/4W, 5%	R0765	A-B 1K, 1/4W, 5%
R22	Resistor, 22K, 1/4W, 5%	R0768	A-B 22K, 1/4W, 5%
R23	Resistor, 220K, 1/4W, 5%	R0967	A-B 220K, 1/4W, 5%
U1	Integrated Circuit, μ723C	25756	Fairchild U5R7723393
U2	Integrated Circuit, μ723C	25756	Fairchild U5R7723393
U3	Integrated Circuit, μ723C	25756	Fairchild U5R7723393
U4	Integrated Circuit, μ723C	25756	Fairchild U5R7723393

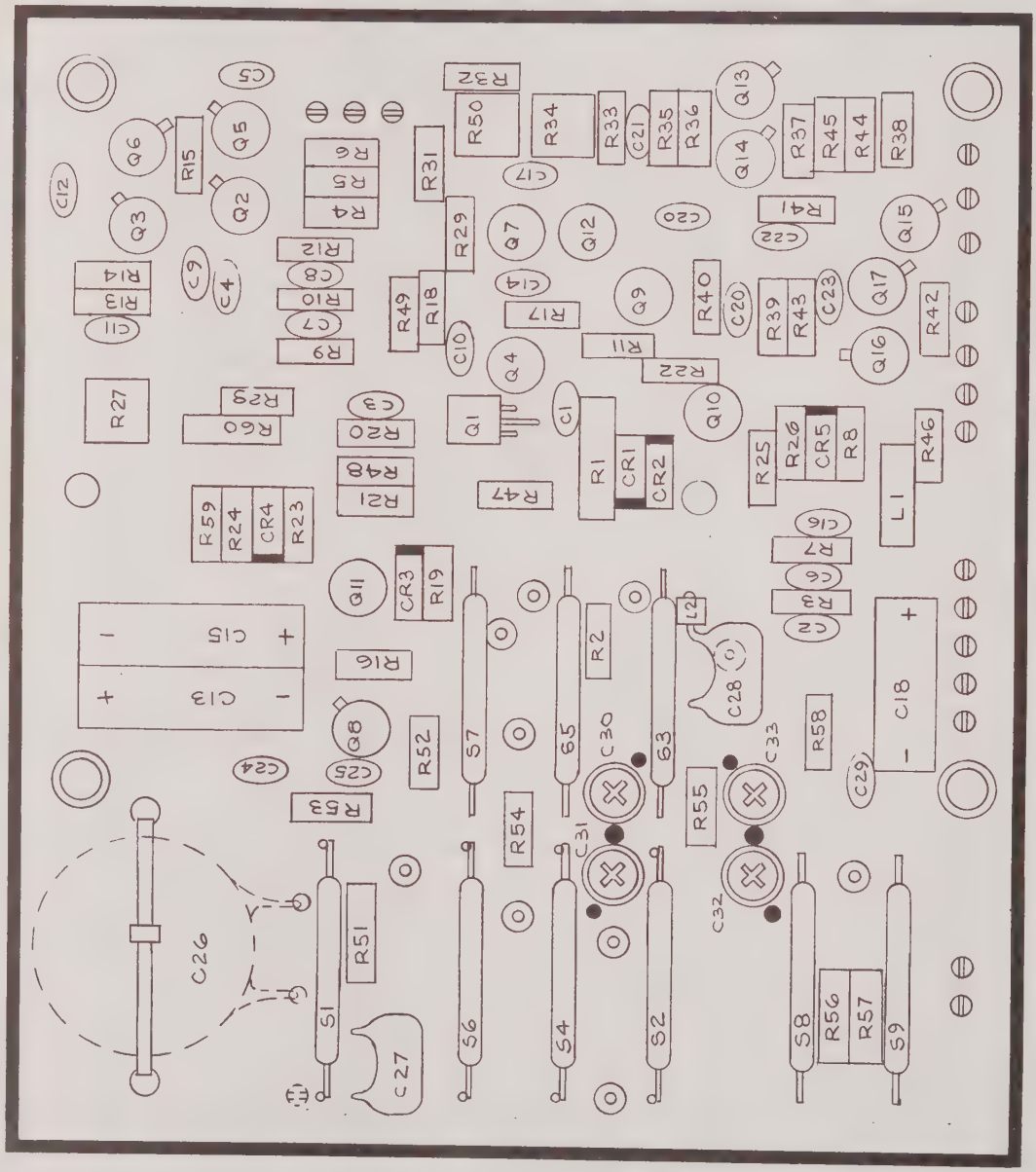


Figure 6-4. Assembly 100 MHz A-Amplifier [33262]

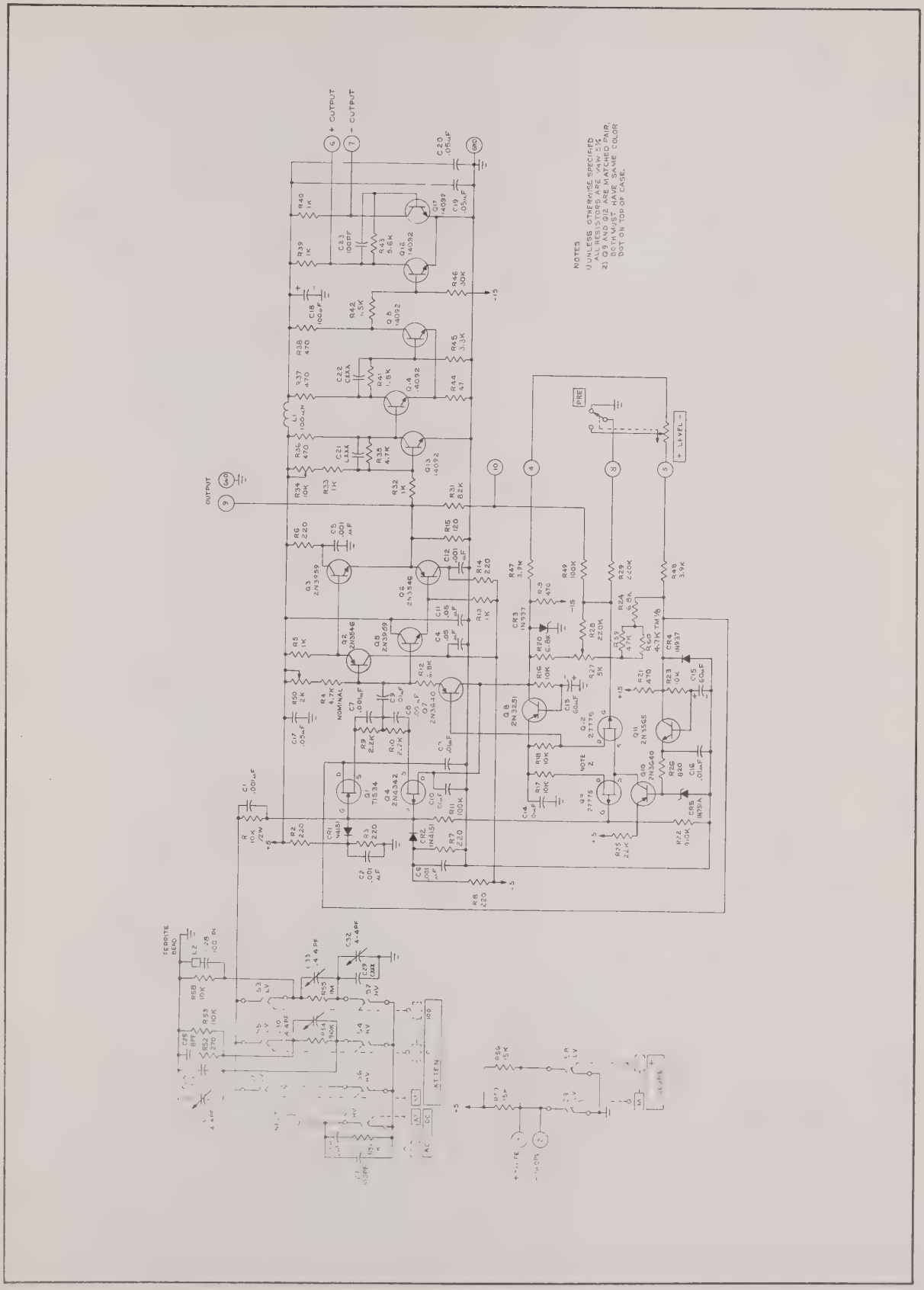


Figure 6-5. Schematic 100 MHz A-Amplifier [33295]

100 MHz "A" AMP Parts List

Ref.	Description	SD Part No.	Manufacturers Part No.
	100 MHz A Amp P.C. Assembly	33262	
C1	Capacitor, .001μF, 1kV Disc.	C0235	Centralab DD102
C2	Capacitor, .001μF, 1kV Disc.	C0235	Centralab DD102
C3	Capacitor, .01μF, 150V, Disc.	C0233	Centralab DDM103
C4	Capacitor, .05μF, 12V, Disc.	C0672	RMC Type M-12
C5	Capacitor, .001μF, 1kV, Disc.	C0235	Centralab DD102
C6	Capacitor, .001μF, 1kV, Disc.	C0235	Centralab DD102
C7	Capacitor, .001μF, 1kV, Disc.	C0235	Centralab DD102
C8	Capacitor, .001μF, 1kV, Disc.	C0235	Centralab DD102
C9	Capacitor, .01μF, 150V, Disc.	C0233	Centralab DDM103
C10	Capacitor, .01μF, 150V, Disc.	C0233	Centralab DDM103
C11	Capacitor, .05μF, 12V, Disc.	C0672	RMC Type M-12
C12	Capacitor, .001μF, 1kV, Disc.	C0235	Centralab DD102
C13	Capacitor, 60μF, 50V, Tant	C0511	
C14	Capacitor, .01μF, 150V, Disc.	C0233	Centralab DDM103
C15	Capacitor, 60μF, 50V, Tant	C0511	
C16	Capacitor, .01μF, 150V, Disc.	C0233	Centralab DDM103
C17	Capacitor, .05μF, 12V, Disc.	C0672	RMC Type M-12
C18	Capacitor, 100μF, 10V, Tant	C0369	GE62F301
C19	Capacitor, .05μF, 12V, Disc.	C0672	RMC Type M-12
C20	Capacitor, .05μF, 12V Disc.	C0672	RMC Type M-12
C21	Cxx		
C22	Cxx		
C23	Capacitor, 100pF, Mica	C1156	
C24	Cxx		
C25	Capacitor, 8pF, 500V, Disc.	C0597	
C26	Capacitor, .1μF, 500V, Disc. 20%	C1106	Sprague SGA-P10
C27	Capacitor, 100pF, 500V, Mica	C1075	
C28	Capacitor, 100pF, 500V, Mica	C1075	
C29	Cxx		
C30	Not Available		
C31	Not Available		
C32	Not Available		
C33	Not Available		
CR1	Diode, 1N4151	CR0150	
CR2	Diode, 1N4151	CR0150	

100 MHz "A" AMP Parts List (con't.)

Ref.	Description	SD Part No.	Manufacturers Part No.
CR3	Diode, 1N937	CR0109	
CR4	Diode, 1N937	CR0109	
CR5	Diode, 1N751A	CR0095	
L1	Inductor, 100µH	L0073	Stanwyck Dink .15
L2	Ferrite Bead	H0654	Ferroxcube 56-590-65/38
Q1	Transistor, T1534	Q0244	
Q2	Transistor, 2N3546	Q0192	
Q3	Transistor, 2N3959	Q0200	
Q4	Transistor, 2N4342	Q0243	
Q5	Qn3959	Q0200	
Q6	Transistor, 2N3546	Q0192	
Q7	Transistor, 2N3640	Q0178	
Q8	Transistor, 2N3251	Q0174	
Q9	Matched Pair	27775	
Q10	Transistor, 2N3640	Q0178	
Q11	Transistor, 2N3656	Q0237	
Q12	Matched Pair	27775	
Q13	Transistor, 14092	14092	
Q14	Transistor, 14092	14092	
Q15	Transistor, 14092	14092	
Q16	Transistor, 14092	14092	
Q17	Transistor, 14092	14092	
R1	Resistor, 10k, 1/2W, 5%	R0292	Allen Bradley CB1035
R2	Resistor, 220Ω, 1/4W, 5%	R0760	Allen Bradley CB2215
R3	Resistor, 220Ω, 1/4W, 5%	R0760	Allen Bradley CB2215
R4	Resistor, 4.7k, 1/4W, 5%	R0892	Allen Bradley CB4725
R5	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R6	Resistor, 220Ω, 1/4W, 5%	R0769	Allen Bradley CB2215
R7	Resistor, 220Ω, 1/4W, 5%	R0760	Allen Bradley CB2215
R8	Resistor, 220Ω, 1/4W, 5%	R0760	Allen Bradley CB2215
R9	Resistor, 2.2k, 1/4W, 5%	R0749	Allen Bradley CB2225
R10	Resistor, 2.2k, 1/4W, 5%	R0749	Allen Bradley CB2225
R11	Resistor, 100k, 1/4W, 5%	R0741	Allen Bradley CB1045
R12	Resistor, 6.8k, 1/4W, 5%	R0696	Allen Bradley CB6825
R13	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R14	Resistor, 220Ω, 1/4W, 5%	R0760	Allen Bradley CB2215

Ref.	Description	SD Part No.	Manufacturers Part No.
R15	Resistor, 120Ω, 1/4W, 5%	R1461	Allen Bradley CB1215
R16	Resistor, 10k, 1/4W, 5%	R0766	Allen Bradley CB1035
R17	Resistor, 10k, 1/4W, 5%	R0766	Allen Bradley CB1035
R18	Resistor, 10k, 1/4W, 5%	R0766	Allen Bradley CB1035
R19	Resistor, 470Ω, 1/4W, 5%	R0144	Allen Bradley CB4715
R20	Resistor, 6.8k, 1/4W, 5%	R0696	Allen Bradley CB6825
R21	Resistor, 470Ω, 1/4W, 5%	R1044	Allen Bradley CB4715
R22	Resistor, 910k, 1/4W, 5%	R2312	Allen Bradley CB9135
R23	Resistor, 10k, 1/4W, 5%	R0766	Allen Bradley CB1035
R24	Resistor, 6.8k, 1/4W, 5%	R0696	Allen Bradley CB6825
R25	Resistor, 22k, 1/4W, 5%	R0768	Allen Bradley CB2225
R26	Resistor, 820Ω, 1/4W, 5%	R0762	Allen Bradley CB8215
R27	Resistor, POT, 5k, 1/2W, 30%	R2187	Helipot 62PR5K
R28	Resistor, 220k, 1/4W, 5%	R0967	Allen Bradley CB2235
R30	Resistor, 220k, 1/4W, 5%	R0967	Allen Bradley CB2235
R31	Resistor, 82k, 1/4W, 5%	R0784	Allen Bradley CB8235
R32	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R33	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R34	Resistor, POT, 10k	R2383	Helipot 62PR10k
R35	Resistor, 4.7k, 1/4W, 5%	R0892	Allen Bradley CB4725
R36	Resistor, 470Ω, 1/4W, 5%	R0144	Allen Bradley CB4715
R37	Resistor, 470Ω, 1/4W, 5%	R0144	Allen Bradley CB4715
R38	Resistor, 470Ω, 1/4W, 5%	R0144	Allen Bradley CB4715
R39	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R40	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R41	Resistor, 1.8k, 1/4W, 5%	R0959	Allen Bradley CB1825
R42	Resistor, 1.5k, 1/4W, 5%	R0783	Allen Bradley CB1525
R43	Resistor, 5.6k, 1/4W, 5%	R0821	Allen Bradley CB5625
R44	Resistor, 47Ω, 1/4W, 5%	R0743	Allen Bradley CB4705
R45	Resistor, 3.3k, 1/4W, 5%	R0742	Allen Bradley CB3325
R46	Resistor, 30k, 1/4W, 5%	R0715	Allen Bradley CB3035
R47	Resistor, 3.9k, 1/4W, 5%	R0939	Allen Bradley CB3925
R48	Resistor, 3.9k, 1/4W, 5%	R0939	Allen Bradley CB3925
R49	Resistor, 100k, 1/4W, 5%	R0741	Allen Bradley CB1045
R50	Resistor, POT, 2k	R2382	Helipot 62PR2K
R51	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025

100 MHz "A" Amp Parts List

Ref.	Description	SD Part No.	Manufacturers Part No.
R52	Resistor, 270Ω, 1/4W, 5%	R0694	Allen Bradley CB2715
R53	Resistor, 100k, 1/4W, 5%	R1010	Allen Bradley CB1135
R54	Resistor, 910k, 1/4W, 5%	R2312	Allen Bradley CB9135
R55	Resistor, 1M, 1/4W, 5%	R0962	Allen Bradley CB1055
R56	Resistor, 15k, 1/4W, 5%	R0728	Allen Bradley CB1525
R57	Resistor, 15k, 1/4W, 5%	R0728	Allen Bradley CB1525
R58	Resistor, 10k, 1/4W, 5%	R0766	Allen Bradley CB1035
R59	Resistor, 47k, 1/4W, 5%	R0777	Allen Bradley CB4725
R60	Resistor, 4.7k (TM 1/8) 1/8W, 10%	R2589	
S1	Switch, Reed, 1500V	19369	
S2	Switch, Reed, 1500V	19369	
S3	Switch, Reed, 15V	19368	
S4	Switch, Reed, 1500V	19369	
S5	Switch, Reed, 15V	19368	
S6	Switch, Reed, 1500V	19369	
S7	Switch, Reed, 15V	19368	
S8	Switch, Reed, 15V	19368	
S9	Switch, Reed, 15V	19368	

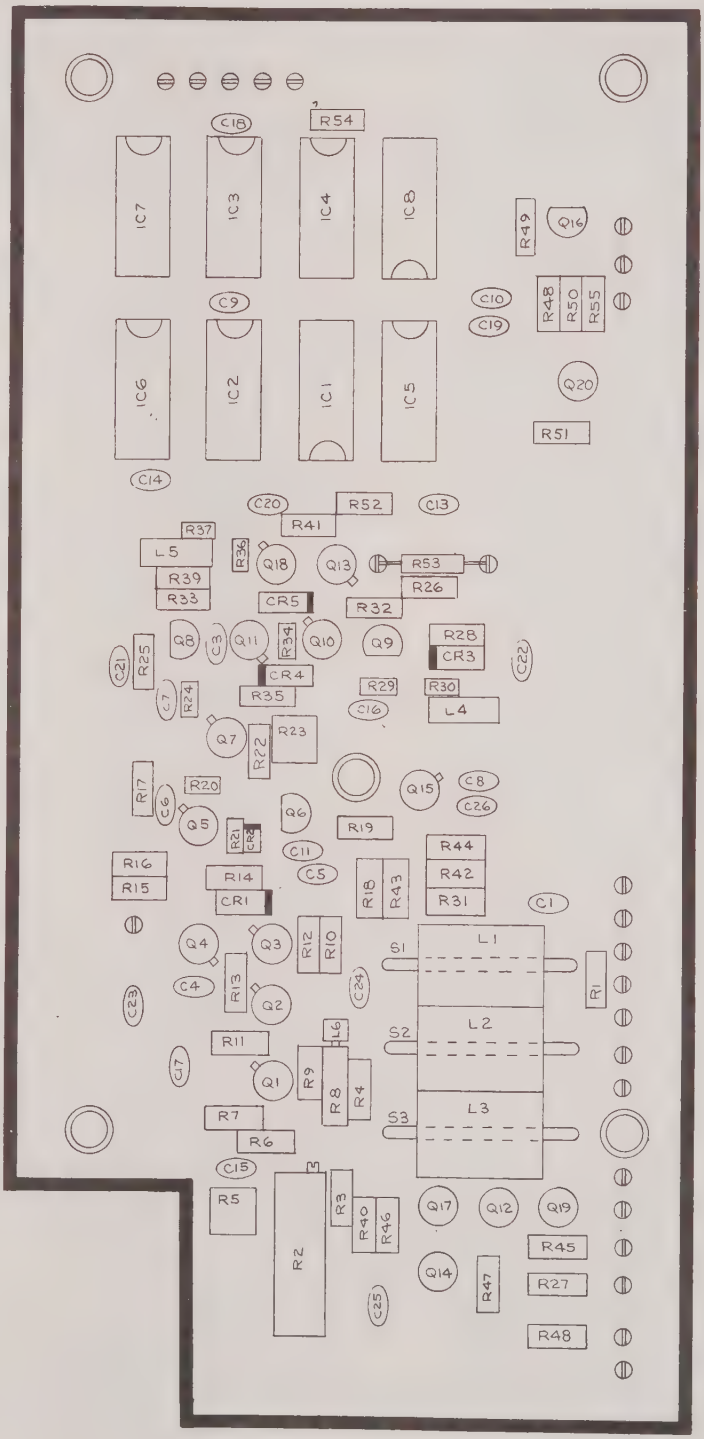


Figure 6-6. Assembly 100 MHz Amp & Decade [33288]

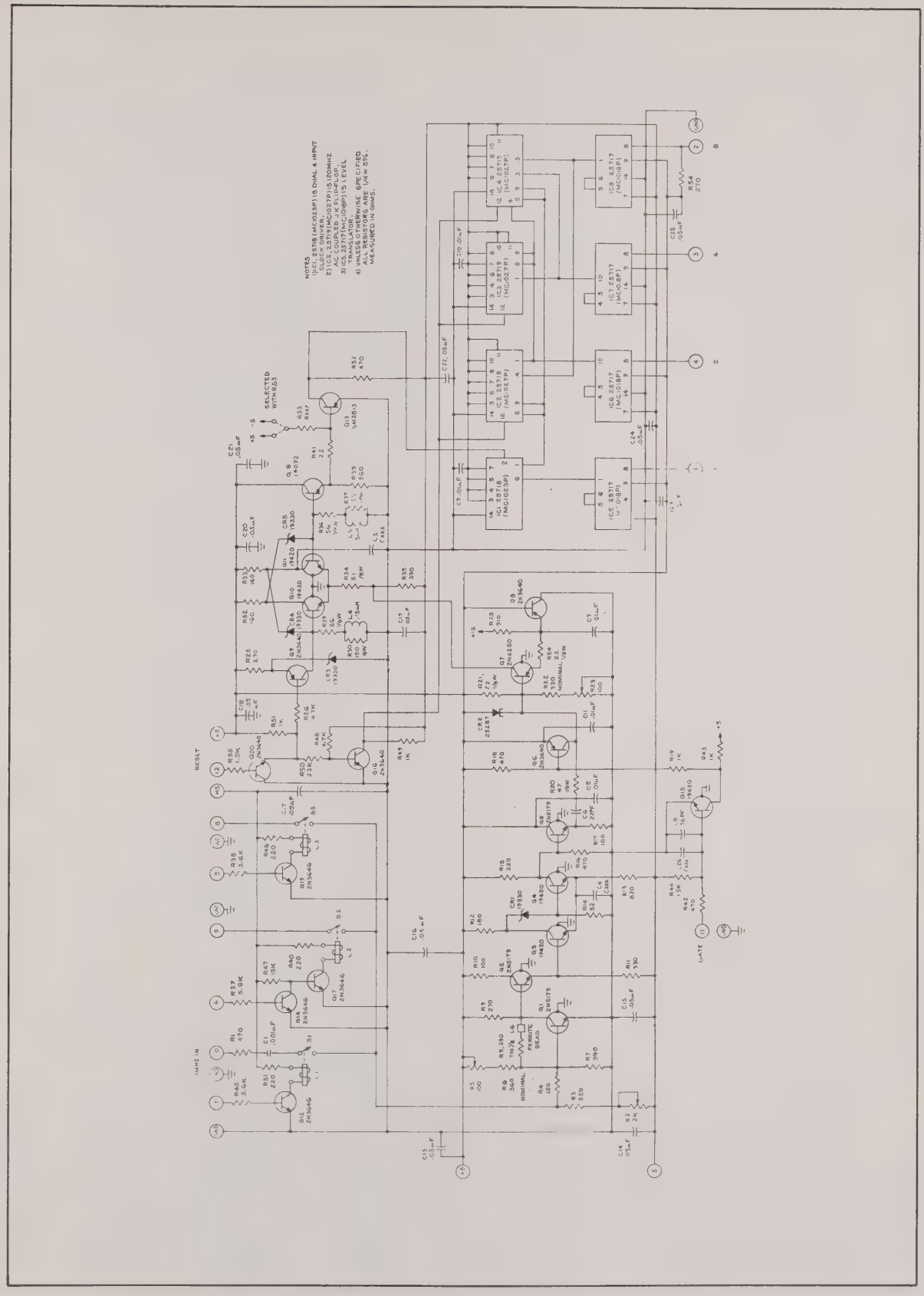


Figure 6-7. Schematic 100 MHz Amp & Decade [33285A]

100 MHz AMP & Decade P.C. Assembly Parts List

Ref.	Description	SD Part No.	Manufacturers Part No.
C1	Capacitor, .001μF, Disc.	C0235	Centralab DD102
C2	Not Used		
C3	Capacitor, (Factory Selected Value)		
C4	Capacitor, (Factory Selected Value)		
C5	Capacitor, .01μF, Disc. 100V	C0556	RMC TA110
C6	Capacitor, 22pF	C0529	Elmenco DM15C-220k-500V
C7	Capacitor, 0.1μF, Disc. 100V	C0556	RMC TA110
C8	Capacitor, 56pF	C0534	Elmenco DM-15E-560k-500
C9	Capacitor, .01μF, Disc. 100V	C0556	RMC TA110
C10	Capacitor, .01μF, Disc. 100V	C0556	RMC TA110
C11	Capacitor, .01μF, Disc. 100V	C0556	RMC TA110
C12	Not Used		
C13	Capacitor, .05μF	C0672	RMC Type M-12
C14	Capacitor, .05μF	C0672	RMC Type M-12
C15	Capacitor, .05μF	C0672	RMC Type M-12
C16	Capacitor, .05μF	C0672	RMC Type M-12
C17	Capacitor, .05μF	C0672	RMC Type M-12
C18	Capacitor, .05μF	C0672	RMC Type M-12
C19	Capacitor, .05μF	C0672	RMC Type M-12
C20	Capacitor, .05μF	C0672	RMC Type M-12
C21	Capacitor, .05μF	C0672	RMC Type M-12
C22	Capacitor, .05μF	C0672	RMC Type M-12
C23	Capacitor, .05μF	C0672	RMC Type M-12
C24	Capacitor, .05μF	C0672	RMC Type M-12
C25	Capacitor, .05μF	C0672	RMC Type M-12
C26	Capacitor, (Factory Selected Value)		
CR1	Diode, 19330	19330	
CR2	Diode, 25287	25287	
CR3	Diode, 19330	19330	
CR4	Diode, 19330	19330	
CR5	Diode, 19330	19330	
L1	Coil, Reed Switch	L0147	Coto Coil U-20003
L2	Coil, Reed Switch	L0147	Coto Coil U-20003
L3	Coil, Reed Switch	L0147	Coto Coil U-20003
L4	Choke, .15μH	L0069	Stanwyck Dink .15
L5	Choke, .15μH	L0069	Stanwyck Dink .15

100 MHz AMP & Decade P.C. Assembly Parts List (con't.)

Ref.	Description	SD Part No.	Manufacturers Part No.
L6	Ferrite Bead	H0654	Ferroxcube 56-590-65/3B
H2	Ferrite Bead	H0654	Ferroxcube 56-590-65/3B
IC1	Integrated Circuit, MC1023P	25718	
IC2	Integrated Circuit, MC1027P	25719	
IC3	Integrated Circuit, MC1027P	25719	
IC4	Integrated Circuit, MC1027P	25719	
IC5	Integrated Circuit, MC1018P	25717	
IC6	Integrated Circuit, MC1018P	25717	
IC7	Integrated Circuit, MC1018P	25717	
IC8	Integrated Circuit, MC1018P	25717	
Q1	Transistor, 2N5179	Q0269	
Q2	Transistor, 2N5179	Q0269	
Q3	Transistor, 19420	19420	
Q4	Transistor, 19420	19420	
Q5	Transistor, 2N5179	Q0269	
Q6	Transistor, 2N3640	Q0178	
Q7	Transistor, 2N4260	Q0272	
Q8	Transistor, 2N3640	Q0178	
Q9	Transistor, 2N3640	Q0178	
Q10	Transistor, 19420	19420	
Q11	Transistor, 19420	19420	
Q12	Transistor, 2N3646	Q0218	
Q13	Transistor, SM2813	Q0270	
Q14	Transistor, 2N3646	Q0218	
Q15	Transistor, 19420	19420	
Q16	Transistor, 2N3640	QO178	
Q17	Transistor, 2N3646	Q0218	
Q18	Transistor, 14092	14092	
Q19	Transistor, 2N3646	Q0218	
Q20	Transistor, 2N3646	QO218	
S1	Reed Switch, 15V	S0326	
S2	Reed Switch, 15V	S0326	
S3	Reed Switch, 15V	S0326	
R1	Resistor, 470Ω, 1/4W, 5%	R1044	Allen Bradley CB4715
R2	Resistor, 2k POT	R1287	Bourns 3067P-1-202

100 MHz AMP & Decade P.C. Assembly Parts List (con't.)

Ref.	Description	SD Part No.	Manufacturers Part No.
R3	Resistor, 220Ω, 1/4W, 5%	R0760	Allen Bradley CB2215
R4	Resistor, 120Ω, 1/4W, 5%	R1461	Allen Bradley CB1215
R5	Resistor, 100Ω POT	R2374	(CTS-340)
R6	Resistor, 560Ω, 1/4W, 5%	R0819	Allen Bradley CB5615
R7	Resistor, 390Ω, 1/4W, 5%	R0880	Allen Bradley CB3915
R8	Resistor, Temp. Sensing 390	R2446	T.I. (TM 1/8)
R9	Resistor, 270Ω, 1/4W, 5%	R0694	Allen Bradley CB2715
R10	Resistor, 100Ω, 1/4W, 5%	R0966	Allen Bradley CB1025
R11	Resistor, 330Ω, 1/4W, 5%	R0662	Allen Bradley CB3315
R12	Resistor, 180Ω, 1/4W, 5%	R1233	Allen Bradley CB1815
R13	Resistor, 820Ω, 1/4W, 5%	R0762	Allen Bradley CB8215
R14	Resistor, 82Ω, 1/4W, 5%	R1059	Allen Bradley CB8205
R15	Resistor, 220Ω, 1/4W, 5%	R0760	Allen Bradley CB2215
R16	Resistor, 470Ω, 1/4W, 5%	R1044	Allen Bradley CB4715
R17	Resistor, 100Ω, 1/4W, 5%	R0966	Allen Bradley CB1025
R18	Resistor, 270Ω, 1/4W, 5%	R1044	Allen Bradley CB2715
R19	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R20	Resistor, 47Ω, 1/8W, 5%	R1449	
R21	Resistor, 22Ω, 1/8W, 5%	R1448	
R22	Resistor, 330Ω, 1/4W, 5%	R0662	Allen Bradley CB3315
R23	Resistor, 100Ω, POT	R2374	(CTS-340)
R24	Resistor, 22Ω, 1/8W, 5%	R1448	
R25	Resistor, 910Ω, 1/4W, 5%	R1795	Allen Bradley CB9115
R26	Resistor, 4.7k, 1/4W, 5%	R0892	Allen Bradley CB4725
R27	Resistor, 5.6k, 1/4W, 5%	R0821	Allen Bradley CB5625
R28	Resistor, 270Ω, 1/4W, 5%	R0694	Allen Bradley CB2715
R29	Resistor, 56Ω, 1/8W, 5%	R1833	
R30	Resistor, 150Ω, 1/8W, 5%	R1442	Allen Bradley 150 DHM
R31	Resistor, 220Ω, 1/4W, 5%	R0760	Allen Bradley CB2215
R32	Resistor, 160Ω, 1/4W, 5%	R1572	Allen Bradley CB1615
R33	Resistor, 160Ω, 1/4W, 5%	R1572	Allen Bradley CB1615
R34	Resistor, 51Ω, 1/8W, 5%	R1832	
R35	Resistor, 390Ω, 1/4W, 5%	R0880	Allen Bradley CB3915
R36	Resistor, 56Ω, 1/8W, 5%	R1833	
R37	Resistor, 150Ω, 1/8W, 5%	R1442	Allen Bradley 150 DHM
R38	Resistor, 5.6k, 1/4W, 5%	R0821	Allen Bradley CB5625
R39	Resistor, 560Ω, 1/4W, 5%	R0819	Allen Bradley CB5615

100 MHz AMP & Decade P.C. Assembly Parts List (con't.)

Ref.	Description	SD Part No.	Manufacturers Part No.
R40	Resistor, 220Ω, 1/4W, 5%	R0760	Allen Bradley CB2215
R41	Resistor, 22Ω, 1/4W, 5%	R1436	Allen Bradley CB2205
R42	Resistor, 470Ω, 1/4W, 5%	R1044	Allen Bradley CB4715
R43	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R44	Resistor, 1.5k, 1/4W, 5%	R0783	Allen Bradley CB1525
R45	Resistor, 5.6k, 1/4W, 5%	R0821	Allen Bradley CB5625
R46	Resistor, 220Ω, 1/4W, 5%	R0760	Allen Bradley CB2215
R47	Resistor, 15k, 1/4W, 5%		Allen Bradley CB1525
R48	Resistor, 4.7k, 1/4W, 5%	R0892	Allen Bradley CB4725
R49	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R50	Resistor, 2.2k, 1/4W, 5%	R0749	Allen Bradley CB2225
R51	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R52	Resistor, 470Ω, 1/4W, 5%	R1044	Allen Bradley CB4715
R53	Resistor, (Factory Selected Value)		
R54	Resistor, 270Ω, 1/4W, 5%	R0694	Allen Bradley CB2715
R55	Resistor, 1.5k, 1/4W, 5%	R0783	Allen Bradley CB1525

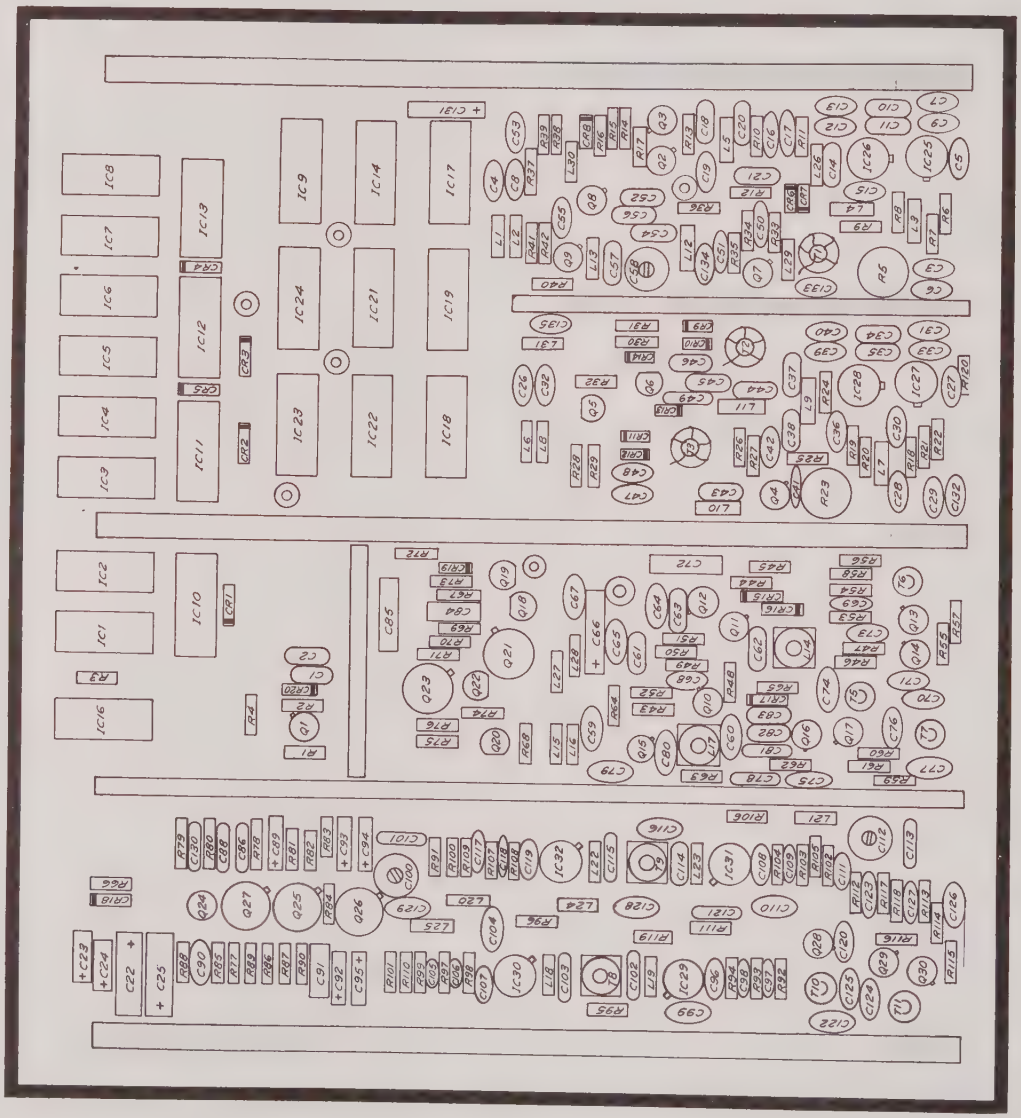


Figure 6-8. ACTO [23733B]

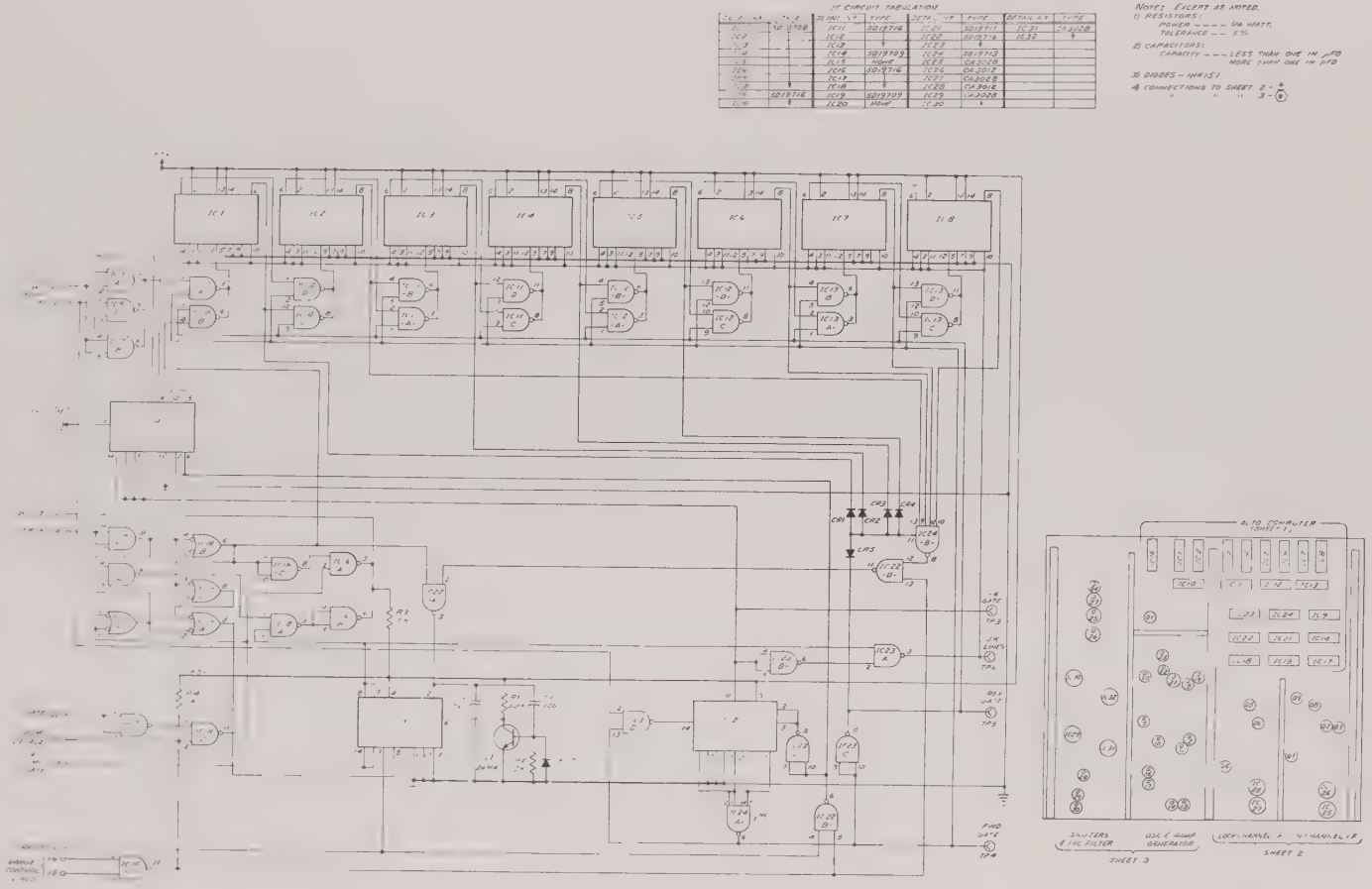


Figure 6-9. Schematic ACTO P.C. Assembly [23730]

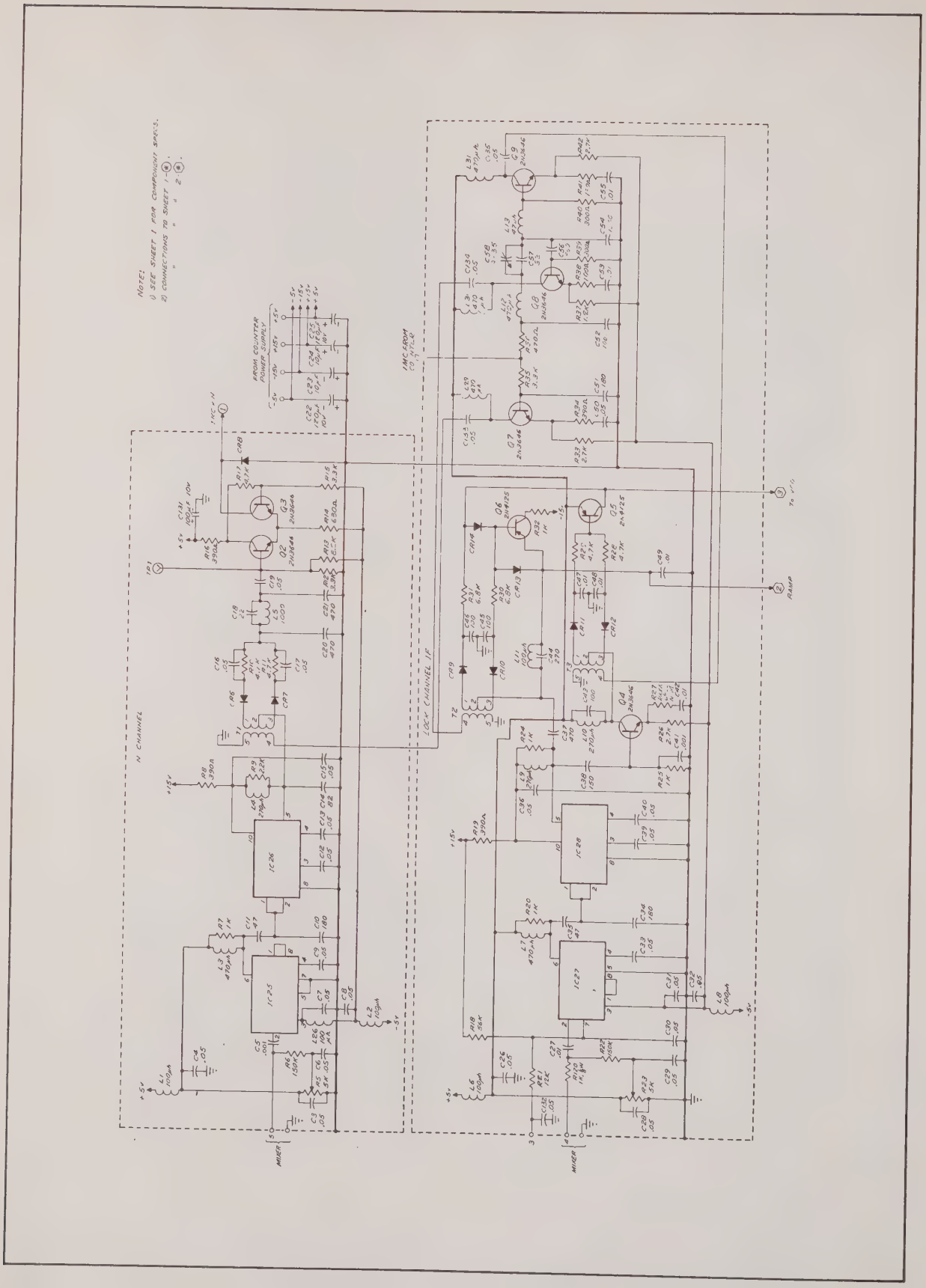


Figure 6-10. Schematic ACTO Sheet 2 [23730]

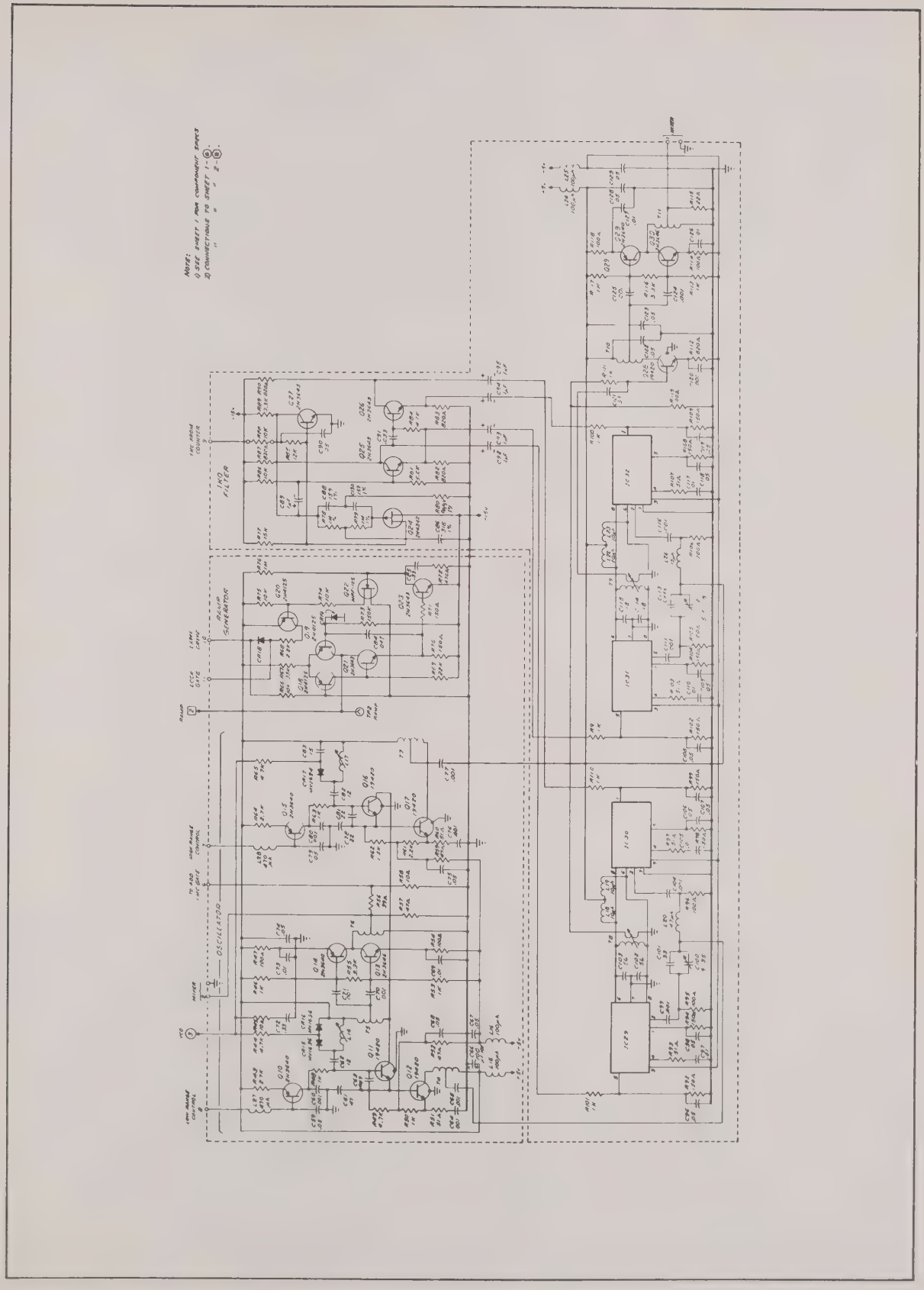


Figure 6-11. Schematic ACTO P.C. Assembly Sheet 3 [23730]

ACTO P.C. Board Parts List

Ref.	Description	SD Part No.	Manufacturers Part No.
	Assembly Acto P.C. Board	23733	
C1	Capacitor, 100pF	C1075	
C2	Capacitor, 82pF Dipmica	C0873	Elmenco DM-15E0820J
C3	Capacitor, .05µF	C0675	Centralab UK-10-503
C4	Capacitor, .05µF	C0675	Centralab UK-10-503
C5	Capacitor, .001µF	C0424	RMC Type B
C6	Capacitor, .05µF	C0675	Centralab UK-10-503
C7	Capacitor, .05µF	C0675	Centralab UK-10-503
C8	Capacitor, .05µF	C0675	Centralab UK-10-503
C9	Capacitor, .05µF	C0675	Centralab UK-10-503
C10	Capacitor, 180pF, Dipmica	C1138	Sangame D155E181J
C11	Capacitor, 47pF	C1074	
C12	Capacitor, .05µF	C0675	Centralab UK-10-503
C13	Capacitor, .05µF	C0675	Centralab UK-10-503
C14	Capacitor, .05µF	C0675	Centralab UK-10-503
C15	Capacitor, .05µF	C0675	Centralab UK-10-503
C16	Capacitor, .05µF	C0675	Centralab UK-10-503
C17	Capacitor, .05µF	C0675	Centralab UK-10-503
C18	Capacitor, .05µF	C0675	Centralab UK-10-503
C19	Capacitor, .05µF	C0675	Centralab UK-10-503
C20	Capacitor, 22pF	C1072	
C21	Capacitor, 470pF	C1078	Sangamo D153E471J0
C22	Capacitor, 120µF	C6732	Kemet K120-P10
C23	Capacitor, 10µF	C0510	GE 62F20J
C24	Capacitor, 10µF	C0510	GE 62F20J
C25	Capacitor, 120µF	C6732	Kemet K120-P10
C26	Capacitor, .05µF	C0675	Centralab UK-10-503
C27	Capacitor, .01µF	C0562	Sprague TGS10
C28	Capacitor, .05µF	C0675	Centralab UK-10-503
C29	Capacitor, .05µF	C0675	Centralab UK-10-503
C30	Capacitor, .05µF	C0675	Centralab UK-10-503
C31	Capacitor, .05µF	C0675	Centralab UK-10-503
C32	Capacitor, .05µF	C0675	Centralab UK-10-503
C33	Capacitor, .05µF	C0675	Centralab UK-10-503
C34	Capacitor, 180pF, Dipmica	C1138	Sangamo D155E181J
C35	Capacitor, 47pF	C1074	

ACTO P.C. Board Parts List (con't.)

Ref.	Description	SD Part No.	Manufacturers Part No.
C36	Capacitor, .05μF	C0675	Centralab D155E181J
C37	Capacitor, 470pF	C1078	Sangamo D153E471J0
C38	Capacitor, 150pF	C1076	Sangamo D155E151J0
C39	Capacitor, .05μF	C0675	Centralab D155E181J
C40	Capacitor, .05μF	C0675	Centralab D155E181J
C41	Capacitor, .001μF	C0424	RMC Type B
C42	Capacitor, .01μF	C0562	Sprague TGS10
C43	Capacitor, 100pF	C1075	
C44	Capacitor, 270pF, Dipmica	C1139	Sangamo D115E271J
C45	Capacitor, 100pF	C1075	
C46	Capacitor, 100pF	C1075	
C47	Capacitor, .01μF	C0562	Sprague TGS10
C48	Capacitor, .01μF	C0562	Sprague TGS10
C49	Capacitor, .01μF	C0562	Sprague TGS10
C50	Capacitor, .01μF	C0675	Centralab UK-10-503
C51	Capacitor, 180pF, Dipmica	C1138	Sangamo D155E181J
C52	Capacitor, 100pF, Mica	C1144	Sangamo D151E1025
C53	Capacitor, .01μF	C0562	Sprague TGS10
C54	Capacitor, 1000pF, Mica	C1144	Sangamo D151E102J
C55	Capacitor, .01μF	C0562	Sprague TGS10
C56	Capacitor, 500pF	C1079	
C57	Capacitor, 33pF	C1073	
C58	Capacitor, 9-35pF, Trimmer	C0709	
C59	Capacitor, .05μF	C0675	Centralab UK-10-503
C60	Capacitor, .001μF	C0424	RMC Type B
C61	Capacitor, 47pF	C1074	
C62	Capacitor, 12pF, Dipmica	C1141	Sangamo D155C120J
C63	Capacitor, 47pF	C1074	
C64	Capacitor, .001μF	C0424	RMC Type B
C65	Capacitor, .001μF	C0424	RMC Type B
C66	Capacitor, 100μF, 10V	C0369	GE 62F301
C67	Capacitor, .05μF	C0675	Centralab UK-10-503
C68	Capacitor, .05μF	C0675	Centralab UK-10-503
C69	Capacitor, .01μF	C0562	Sprague TGS10
C70	Capacitor, .001μF	C0424	RMC Type B
C71	Capacitor, .001μF	C0424	RMC Type B
C72	Capacitor, .33μF	C0239	Electron M10334

ACTO P.C. Board Parts List (con't.)

Ref.	Description	SD Part No.	Manufacturers Part No.
C73	Capacitor, .01μF	C0562	Sprague TGS10
C74	Capacitor, .05μF	C0675	Centralab UK-10-503
C75	Capacitor, .05μF	C0675	Centralab UK-10-503
C76	Capacitor, .001μF	C0424	RMC Type B
C77	Capacitor, .001μF	C0424	RMC Type B
C78	Capacitor, 22pF	C1072	
C79	Capacitor, .05μF	C0675	Centralab UK-10-503
C80	Capacitor, .001μF	C0424	RMC Type B
C81	Capacitor, 22pF	C1074	
C82	Capacitor, 12pF, Dipmica	C1141	Sangamo D155C120J
C83	Capacitor, 15pF, Dipmica	C1142	Sangamo D155C150J
C84	Capacitor, .047μF, 100V Mylar	C0788	Electron 2DE1-473
C85	Capacitor, .33μF, 100V	C0239	Electron M1-334
C86	Capacitor, 318pF, 1%, 500V	C1155	Sangamo D155E321F-31
C87	Not Used		
C88	Capacitor, 159pF, 1%, 500V	C1146	Sangamo D155E161F
C89	Capacitor, 1μF, 35V	C0524	Sprague 150D105x9035A2
C90	Capacitor, .05μF	C0675	Centralab UK-10-503
C91	Capacitor, .033μF, 100V	C1202	Electron D1-330
C92	Capacitor, 1μF, 35V	C0524	Sprague 150D105x9035A2
C93	Capacitor, 1μF, 35V	C0524	Sprague 150D105x9035A2
C94	Capacitor, 1μF, 35V	C0524	Sprague 150D105x9035A2
C95	Capacitor, 1μF, 35V	C0524	Sprague 150D105x9035A2
C96	Capacitor, .05μF	C0675	Centralab UK-10-503
C97	Capacitor, .01μF	C0562	Sprague TGS10
C98	Capacitor, .05μF	C0675	Centralab UK-10-503
C99	Capacitor, .001μF	C0424	RMC Type B
C100	Capacitor, 9-35pF, Trimmer	C0709	Erie 530-011-E2 PO-94
C101	Capacitor, 56pF, mica, 25%, 500V	C0882	Elmenco DM-15E-560H
C102	Capacitor, 56pF, mica, 25%, 500V	C0882	Elmenco DM-15E-560H
C103	Capacitor, .001μF	C0424	RMC Type B
C104	Capacitor, .01μF	C0562	Sprague TGS10
C105 Thru	Capacitor, .05μF	C0675	Centralab UK-10-503
C109	Capacitor, .05μF	C0675	Centralab UK-10-503
C110	Capacitor, .01μF	C0562	Sprague TGS10
C111	Capacitor, .001μF	C0424	RMC Type B
C112	Capacitor, 5.5-18pF, Trimmer	C0712	Erie 538-011-NPO-92R

ACTO P.C. Board Parts List (con't.)

Ref.	Description	SD Part No.	Manufacturers Part No.
C113	Cxxx	Cxxx	
C114	Capacitor, 18pF, Dipmica	C1143	Sangamo D115C180J
C115	Capacitor, 18pF, Dipmica	C1143	Sangamo D115C180J
C116	Capacitor, .001μF	C0424	RMC Type B
C117	Capacitor, .01μF	C0562	Sprague TGS10
C118	Capacitor, .05μF	C0675	Centralab UK-10-503
C119	Capacitor, .05μF	C0675	Centralab UK-10-503
C120	Capacitor, .001μF	C0424	RMC Type B
C121	Capacitor, 33pF	C1073	
C122	Capacitor, .05μF	C0675	Centralab UK-10-503
C123	Capacitor, .05μF	C0675	Centralab UK-10-503
C124	Capacitor, .01μF	C0424	Sprague TGS10
C125	Capacitor, .001μF	C0242	RMC Type B
C126	Capacitor, .01μF	C0562	Sprague TGS10
C127	Capacitor, .01μF	C0562	Sprague TGS10
C128	Capacitor, .05μF	C0675	Centralab UK-10-503
C129	Capacitor, .05μF	C0675	Centralab UK-10-503
C130	Capacitor, 159pF, 1%, 500V	C1146	Sangamo D155E161F-159
C131	Capacitor, 100μF, 10V	C0369	GE 62F301
C132	Capacitor, .05μF	C0675	Centralab UK-10-503
C133	Capacitor, .05μF	C0675	Centralab UK-10-503
C134	Capacitor, .05μF	C0675	Centralab UK-10-503
C135	Capacitor, .05μF	C0675	Centralab UK-10-503
CR1	Diode, IN4151	CR0150	
Thru			
CR14	Same as CR1		
CR15	Diode, MV1636, Motorola	CR0354	
CR16	Diode, MV1636, Motorola	CR0354	
CR17	Diode, MV1624, Motorola	CR0353	
CR18	Diode, IN4151	CR0150	
CR19	Diode, IN4151	CR0150	
CR20	Diode, IN4151	CR0150	
L1	Choke, 100μH Wee-Wee 100	L0156	Nytronics Wee-Wee 100
L2	Choke, 100μH Wee-Wee 100	L0156	Nytronics Wee-Wee 100
L3	Choke, 470μH	L0019	Stanwyck Dink 470
L4	Choke, 270μH	L0067	Stanwyck Dink 270
L5	Choke, 1000μH	L0068	Stanwyck Dink 1000

ACTO P.C. Board Parts List (con't.)

Ref.	Description	SD Part No.	Manufacturers Part No.
L6	Choke, 100μH Wee-Wee 100	L0156	Nytronics Wee-Wee 100
L7	Choke, 470μH	L0019	Stanwyck Dink 470
L8	Choke, 100μH Wee-Wee 100	L0156	Nytronics Wee-Wee 100
L9	Choke, 470μH	L0067	Stanwyck Dink 270
L10	Choke, 270μH	L0067	Stanwyck Dink 270
L11	Choke, 100μH Wee-Wee 100	L0156	Nytronics Wee-Wee 100
L12	Choke, 470μH Wee-Wee 470	L0019	Nytronics Wee-Wee 470
L13	Choke, 47μH Wee-Wee 47	L0152	Nytronics Wee-Wee 47
L14	Inductor Assembly	25072-1	
L15	Choke, 100μH, Wee-Wee 100	L0156	Nytronics Wee-Wee 100
L16	Choke, 100μH, Wee-Wee 100	L0156	Nytronics Wee-Wee 100
L17	Inductor Assembly	25072-2	
L18	Choke, 10μH Wee-Wee 10	L0153	Nytronics Wee-Wee 10
L19	Choke, 10μH Wee-Wee 10	L0153	Nytronics Wee-Wee 10
L20	Choke, .47μH Wee-Wee 0.47	L0154	Nytronics Wee-Wee 0.47
L21	Choke, .15μH Wee-Wee 0.15	L0155	Nytronics Wee-Wee 0.15
L22	Choke, 10μH Wee-Wee 10	L0153	Nytronics Wee-Wee 10
L23	Choke, 10μH Wee-Wee 10	L0153	Nytronics Wee-Wee 10
L24	Choke, 100μH Wee-Wee 100	L0156	Nytronics Wee-Wee 100
L25	Choke, 100μH Wee-Wee 100	L0156	Nytronics Wee-Wee 100
L26	Choke, 100μH Wee-Wee 100	L0156	Nytronics Wee-Wee 100
L27	Choke, 470μH Wee-Wee 470	L0157	Nytronics Wee-Wee 470
Thru			
L31	Same as L27		
IC1	Integrated Circuit SD19708	19708	
Thru			
IC8	Same as IC1		
IC9	Integrated Circuit SD19716	19716	
Thru			
IC13	Same as IC9		
IC14	Integrated Circuit SD19709	19709	
IC15	Not Used		
IC16	Integrated Circuit SD19716	19716	
IC17	Integrated Circuit SD19716	19716	
IC18	Integrated Circuit SD19716	19716	
IC19	Integrated Circuit SD19709	19709	
IC20	Not Used		
IC21	Integrated Circuit SD19711	19711	

ACTO P.C. Board Parts List (con't.)

Ref.	Description	SD Part No.	Manufacturers Part No.
IC22 Thru IC24	Integrated Circuit SD19716 Same as IC22	19716	
IC25	Integrated Circuit CA3028	25702	
IC26	Integrated Circuit CA3012 RCA	25703	
IC27	Integrated Circuit CA3028 RCA	25702	
IC28	Integrated Circuit CA3012 RCA	25703	
IC29	Integrated Circuit CA3028 RCA	25702	
IC30	Integrated Circuit CA3028 RCA	25702	
IC31	Integrated Circuit CA3028 RCA	25702	
Q1 Thru Q4	Transistor, 2N3646 Same as Q1	Q0218	
Q5	Transistor, 2N4125	Q0262	
Q6	Same as Q5		
Q7 Thru Q9	Transistor, 2N3646 Same as Q7	Q0218	
Q10	Transistor, 2N3640	Q0178	
Q11	Transistor, 19420	19420	
Q12	Transistor, 19420	19420	
Q13	Transistor, 2N3646	Q0218	
Q14	Transistor, 2N3640	Q0178	
Q15	Transistor, 2N3640	Q0178	
Q16	Transistor, 19420	19420	
Q17	Transistor, 19420	19420	
Q18 Thru Q20	Transistor, 2N4125 Same as Q18	Q0262	
Q21	Transistor, 2N3643	Q0179	
Q22	Transistor, MPF 105 Motorola	Q0264	
Q23	Transistor, 2N3643	Q0179	
Q24	Transistor, 2N4342	Q0243	
Q25 Thru Q27	Transistor, 2N3643 Same as Q25	Q0179	
Q28	Transistor, 19420	19420	
Q29	Transistor, 2N3640	Q0178	

ACTO P.C. Board Parts List (con't.)

Ref.	Description	SD Part No.	Manufacturers Part No.
Q30	Transistor, 2N3646	Q0218	
R1	Resistor, 3.3k, 1/4W, 5%	R0742	Allen Bradley CB3325
R2	Resistor, 10k, 1/4W, 5%	R0766	Allen Bradley CB1035
R3	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R4	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R5	Resistor, 5k, POT	R1858	Spectrol 80-3-4-502
R6	Resistor, 150k, 1/4W, 5%	R0961	Allen Bradley CB1535
R7	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R8	Resistor, 390Ω, 1/4W, 5%	R0880	Allen Bradley CB3915
R9	Resistor, 2.2k, 1/4W, 5%	R0749	Allen Bradley CB2225
R10	Resistor, 4.7k, 1/4W, 5%	R0892	Allen Bradley CB4725
R11	Resistor, 4.7k, 1/4W, 5%	R0892	Allen Bradley CB4725
R12	Resistor, 3.3k, 1/4W, 5%	R0742	Allen Bradley CB3325
R13	Resistor, 8.2k, 1/4W, 5%	R0883	Allen Bradley CB8225
R14	Resistor, 680Ω, 1/4W, 5%	R1234	Allen Bradley CB6815
R15	Resistor, 3.3k, 1/4W, 5%	R0742	Allen Bradley CB3325
R16	Resistor, 390Ω, 1/4W, 5%	R0880	Allen Bradley CB3915
R17	Resistor, 4.7k, 1/4W, 5%	R0892	Allen Bradley CB4725
R18	Resistor, 56k, 1/4W, 5%	R1235	Allen Bradley CB5625
R19	Resistor, 390Ω, 1/4W, 5%	R0880	Allen Bradley CB3915
R20	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R21	Resistor, 12k, 1/4W, 5%	R0759	Allen Bradley CB1225
R22	Resistor, 150k, 1/4W, 5%	R0961	Allen Bradley CB1535
R23	Resistor, POT 5k	R1858	Spectrol 80-3-4-502
R24	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R25	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R26	Resistor, 2.7k, 1/4W, 5%	R0937	Allen Bradley CB2725
R27	Resistor, 68Ω, 1/4W, 5%	R1426	Allen Bradley CB6805
R28	Resistor, 4.7k, 1/4W, 5%	R0892	Allen Bradley CB4725
R29	Resistor, 4.7k, 1/4W, 5%	R0892	Allen Bradley CB4725
R30	Resistor, 6.8k, 1/4W, 5%	R0696	Allen Bradley CB6825
R31	Resistor, 6.8k, 1/4W, 5%	R0696	Allen Bradley CB6825
R32	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R33	Resistor, 2.7k, 1/4W, 5%	R0937	Allen Bradley CB2725
R34	Resistor, 390Ω, 1/4W, 5%	R0880	Allen Bradley CB2915
R35	Resistor, 3.3k, 1/4W, 5%	R0742	Allen Bradley CB3325
R36	Resistor, 470Ω, 1/4W, 5%	R1044	Allen Bradley CB4715

ACTO P.C. Board Parts List (con't.)

Ref.	Description	SD Part No.	Manufacturers Part No.
R37	Resistor, 1.2k, 1/4W, 5%	R0809	Allen Bradley CB1225
R38	Resistor, 100Ω, 1/4W, 5%	R0966	Allen Bradley CB1025
R39	Resistor, 300Ω, 1/4W, 5%	R0670	Allen Bradley CB3025
R40	Resistor, 300Ω, 1/4W, 5%	R0670	Allen Bradley CB3025
R41	Resistor, 180Ω, 1/4W, 5%	R1233	Allen Bradley CB1815
R42	Resistor, 2.7k, 1/4W, 5%	R0937	Allen Bradley CB2725
R43	Resistor, 2.7k, 1/4W, 5%	R0937	Allen Bradley CB2725
R44	Resistor, 4.7k, 1/4W, 5%	R0892	Allen Bradley CB4725
R45	Resistor, 10Ω, 1/4W, 5%	R0739	Allen Bradley CB1015
R46	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R47	Resistor, 100Ω, 1/4W, 5%	R0966	Allen Bradley CB1025
R48	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R49	Resistor, 4.7k, 1/4W, 5%	R0892	Allen Bradley CB4725
R50	Resistor, 1k, 1/4W, 5%	R0875	Allen Bradley CB1025
R51	Resistor, 51Ω, 1/4W, 5%	R1246	Allen Bradley CB5105
R52	Resistor, 47Ω, 1/4W, 5%	R0743	Allen Bradley CB4705
R53	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R54	Resistor, 100Ω, 1/4W, 5%	R0966	Allen Bradley CB1025
R55	Resistor, 3.3k, 1/4W, 5%	R0742	Allen Bradley CB3325
R56	Resistor, 39Ω, 1/4W, 5%	R1552	Allen Bradley CB3905
R57	Resistor, 47Ω, 1/4W, 5%	R0743	Allen Bradley CB4705
R58	Resistor, 10Ω, 1/4W, 5%	R0739	Allen Bradley CB1015
R59	Resistor, 47Ω, 1/4W, 5%	R0743	Allen Bradley CB4705
R60	Resistor, 51Ω, 1/4W, 5%	R1246	Allen Bradley CB5105
R61	Resistor, 2.2k, 1/4W, 5%	R0749	Allen Bradley CB2225
R62	Resistor, 1.5k, 1/4W, 5%	R0783	Allen Bradley CB1525
R63	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R64	Resistor, 2.7k, 1/4W, 5%	R0937	Allen Bradley CB2725
R65	Resistor, 4.7k, 1/4W, 5%	R0892	Allen Bradley CB4725
R66	Resistor, 10k, 1/4W, 5%	R0766	Allen Bradley CB1035
R67	Resistor, 33k, 1/4W, 5%	R0780	Allen Bradley CB3325
R68	Resistor, 2.2k, 1/4W, 5%	R0749	Allen Bradley CB2225
R69	Resistor, 22k, 1/4W, 5%	R0768	Allen Bradley CB2225
R70	Resistor, 150Ω, 1/4W, 5%	R0983	Allen Bradley CB1515
R71	Resistor, 150Ω, 1/4W, 5%	R0983	Allen Bradley CB1515
R72	Resistor, 470Ω, 1/4W, 5%	R1044	Allen Bradley CB4715
R73	Resistor, 150k, 1/4W, 5%	R0961	Allen Bradley CB1535
R74	Resistor, 10k, 1/4W, 5%	R0766	Allen Bradley CB1035

ACTO P.C. Board Parts List (con't.)

Ref.	Description	SD Part No.	Manufacturers Part No.
R75	Resistor, 10k, 1/4W, 5%	R0766	Allen Bradley CB1035
R76	Resistor, 1 Meg., 1/4W, 5%	R0962	Allen Bradley CB1005
R78	Resistor, 15k, 1/4W, 5%	R0728	Allen Bradley CB1525
R79	Resistor, 1 Meg. 1/8W, 1%	R2371	Electra MF5C-D-100rF
R80	Resistor, 499k, 1/8W, 1%	R2372	Electra MF5C-D-4993-F
R81	Resistor, 5.6k, 1/4W, 5%	R0821	Allen Bradley CB5625
R82	Resistor, 820Ω, 1/4W, 5%	R0762	Allen Bradley CB8215
R83	Resistor, 820Ω, 1/4W, 5%	R0762	Allen Bradley CB8215
R84	Resistor, 4.7k, 1/4W, 5%	R0892	Allen Bradley CB4725
R85	Resistor, 12k, 1/4W, 5%	R0759	Allen Bradley CB1225
R86	Resistor, 10k, 1/4W, 5%	R0766	Allen Bradley CB1035
R87	Resistor, 820Ω, 1/4W, 5%	R0762	Allen Bradley CB8215
R88	Resistor, 10k, 1/4W, 5%	R0766	Allen Bradley CB1035
R89	Resistor, 3.3k, 1/4W, 5%	R0742	Allen Bradley CB3325
R90	Resistor, 820Ω, 1/4W, 5%	R0762	Allen Bradley CB8215
R91	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R92	Resistor, 150Ω, 1/4W, 5%	R0983	Allen Bradley CB1515
R93	Resistor, 51Ω, 1/4W, 5%	R1246	Allen Bradley CB5105
R94	Resistor, 150Ω, 1/4W, 5%	R0983	Allen Bradley CB1515
R95	Resistor, 100Ω, 1/4W, 5%	R0966	Allen Bradley CB1025
R96	Resistor, 100Ω, 1/4W, 5%	R0966	Allen Bradley CB1025
R97	Resistor, 51Ω, 1/4W, 5%	R1246	Allen Bradley CB5105
R98	Resistor, 150Ω, 1/4W, 5%	R0983	Allen Bradley CB1515
R99	Resistor, 150Ω, 1/4W, 5%	R0983	Allen Bradley CB1515
R100	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R101	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R102	Resistor, 150Ω, 1/4W, 5%	R0083	Allen Bradley CB1515
R103	Resistor, 51Ω, 1/4W, 5%	R1246	Allen Bradley CB5105
R104	Resistor, 150Ω, 1/4W, 5%	R0983	Allen Bradley CB1515
R105	Resistor, 100Ω, 1/4W, 5%	R0966	Allen Bradley CB1025
R106	Resistor, 100Ω, 1/4W, 5%	R0966	Allen Bradley CB1025
R107	Resistor, 51Ω, 1/4W, 5%	R1246	Allen Bradley CB5105
R108	Resistor, 150Ω, 1/4W, 5%	R0983	Allen Bradley CB1515
R109	Resistor, 150Ω, 1/4W, 5%	R0983	Allen Bradley CB1515
R110	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R111	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R112	Resistor, 820Ω, 1/4W, 5%	R0762	Allen Bradley CB8215
R113	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025

ACTO P.C. Board Parts List (con't.)

Ref.	Description	SD Part No.	Manufacturers Part No.
R114	Resistor, 100Ω, 1/4W, 5%	R0966	Allen Bradley CB1025
R115	Resistor, 22Ω, 1/4W, 5%	R1436	Allen Bradley CB2205
R116	Resistor, 3.3k, 1/4W, 5%	R0742	Allen Bradley CB3325
R117	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R118	Resistor, 100Ω, 1/4W, 5%	R0966	Allen Bradley CB1025
R119	Resistor, 100Ω, 1/4W, 5%	R0966	Allen Bradley CB1025
R120	Resistor, 1k, 1/8W, 5%	R1453	Allen Bradley BB1025
T1	Transformer, phase detector	25701	
T2	Transformer, phase detector	25701	
T3	Transformer, phase detector	25701	
T4	Transformer, wideband	25067	
T5	Transformer, wideband	25067	
T6	Transformer, wideband	25067	
T7	Transformer, wideband	25067	
T8	Transformer, Assembly	25072-3	
T9	Transformer, Assembly	25072-4	
T10	Transformer, wideband	25067	
	Terminal	E0100	USEC02000B
TP1	Test Point, Brown	E0284	
TP2	Test Point, Red	C0279	
TP3	Test Point, Orange	E0282	
TP4	Test Point, Yellow	E0283	
TP5	Test Point, Blue	E0281	
TP6	Test Point, Green	E0285	

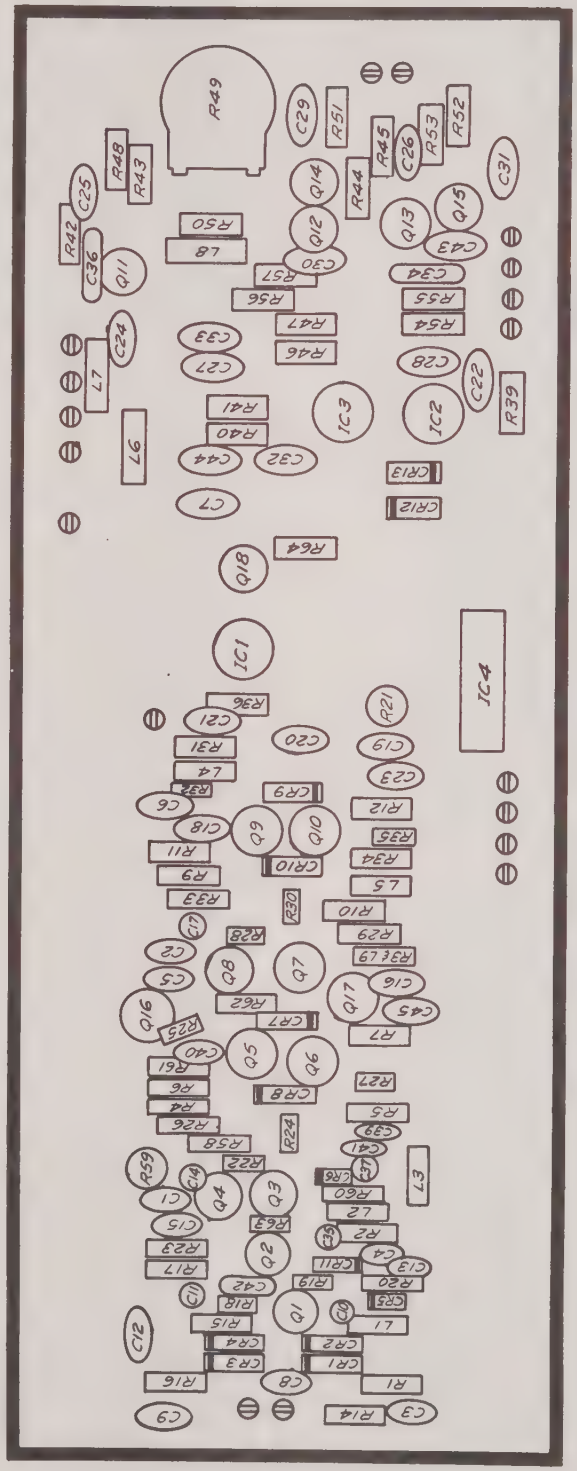


Figure 6-12. 300 MHz Prescaler [25189C]

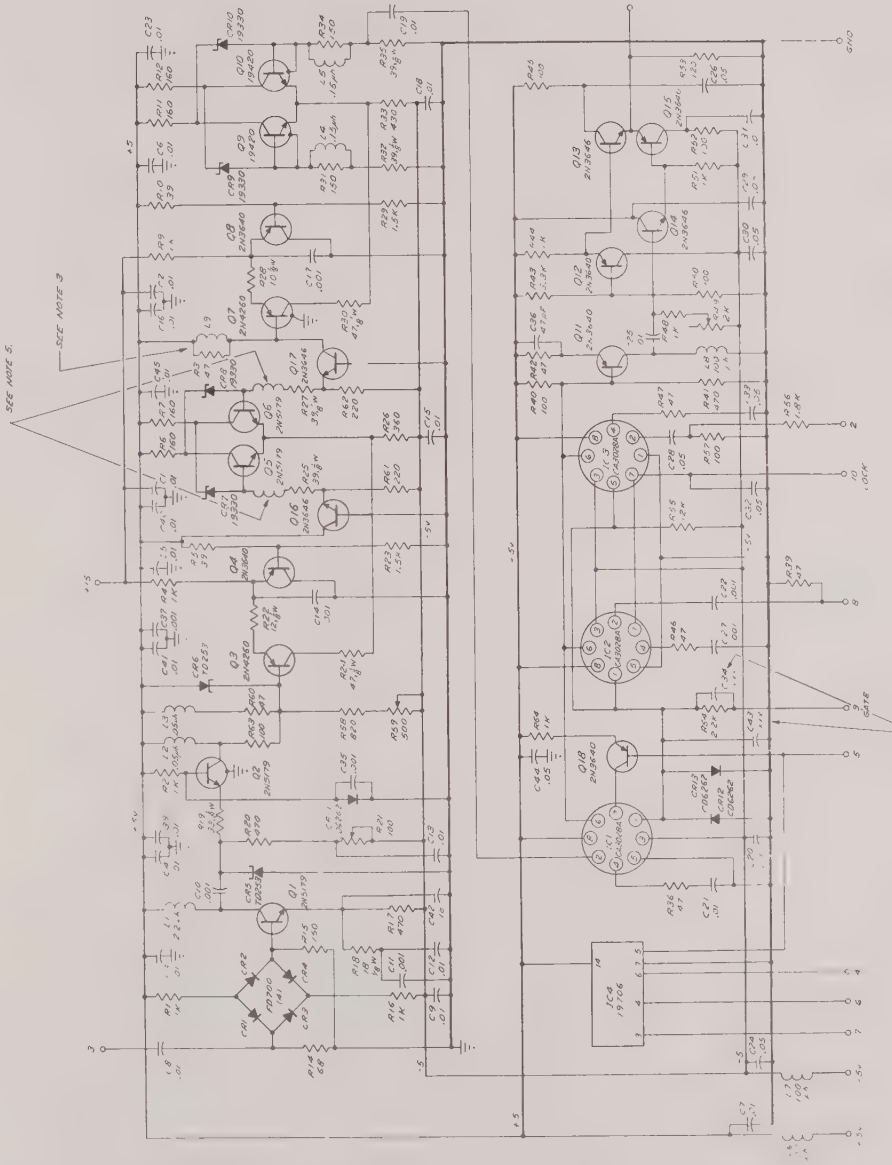

SEE NOTE 3
SEE NOTE 5
SEE NOTE 4
GND
+5
-5
NOTE:
UNLESS OTHERWISE NOTED,
1) RESISTORS: OHMS, 1/4 W, 10% TOLERANCE
2) CAPACITORS: VALUE LESS THAN ONE IN μF. VALUE MORE THAN ONE IN pF.
3) 47 OHM RESISTOR WITH 6 TURNS OF #30 WIRE.
4) VALUE SELECTED AT FACTORY.
5) THE INDUCTANCE IN SERIES WITH R25 & R27 ARE LONG RESISTOR LEADS.

Figure 6-13. Schematic 300 MHz Prescaler [25186]

300 MHz Prescaler Parts List

Ref.	Description	SD Part No.	Manufacturers Part No.
	300 MHz Prescaler P.C. Assembly	25189	
C1 Thru C9	Capacitor, .01μF, 150V, Disc.	C0233	Centralab DDM103
	Same as C1		
C10	Capacitor, .001μF, 750 Min-M-001M	C1155	Gulton Min-M-001M
C11	Capacitor, .001μF, 750 Min-M-001M	C1155	Gulton Min-M-001M
C12	Capacitor, .01μF, 150V, Disc.	C0233	Centralab DDM103
C13	Capacitor, .01μF, 150V, Disc.	C0233	Centralab DDM103
C14	Capacitor, .001μF, 750 Min-M-001M	C1155	Gulton Min-M-001M
C15	Capacitor, .01μF, 150V, Disc.	C0233	Centralab DDM103
C16	Capacitor, .01μF, 150V, Disc.	C0233	Centralab DDM103
C17	Capacitor, .001μF, 750 Min-M-001M	C1155	Gulton Min-M-001M
C18 Thru C21	Capacitor, 150V, Disc.	C0233	Centralab DDM103
	Same as C18		
C22	Capacitor, .001μF	C0424	RMC Type B
C23	Capacitor, .01μF, 150V, Disc.	C0233	Centralab DDM103
C24	Capacitor, .05μF	C0672	RMC Type M-12
C25	Capacitor, .01μF, 150V, Disc.	C0233	Centralab DDM103
C26	Capacitor, .05μF	C0672	RMC Type M-12
C27	Capacitor, .001μF	C0424	RMC Type M-12
C28 Thru C33	Capacitor, .05μF	C0672	RMC Type M-12
	Same as C28		
C34	Capacitor, (Determined at Checkout)		
C35	Capacitor, .001μF, 75V, Min-M-001M	C1155	Gulton Min-M-001M
C36	Capacitor, 47pF	C1074	
C37	Capacitor, .001μF, 75V, Min-M-001M	C1155	Gulton Min-M-001M
C38	Not Used		
C39	Capacitor, .01μF, 150V, Disc.	C0233	Centralab DDM103
C40	Capacitor, .01μF, 150V, Disc.	C0233	Centralab DDM103
C41	Capacitor, .01μF, 150V, Disc.	C0233	Centralab DDM103
C42	Capacitor, 18pF	C1143	Sangamo D155C180J
C43	Capacitor, (Determined at Checkout)		
C44	Capacitor, .05μF	C0672	RMC Type M-12
C45	Capacitor, .01μF, 150V, Disc.	C0233	Centralab DDM103
CR1	Diode, FD700	CR0356	Fairchild

300 MHz Prescaler Parts List (con't.)

Ref.	Description	SD Part No.	Manufacturers Part No.
CR2	Diode, FD700	CR0356	Fairchild
CR3	Diode, FD700	CR0356	Fairchild
CR4	Diode, FD700	CR0356	Fairchild
CR5	Diode TD253	S25287	
CR6	Diode TD253	S25287	
CR7 Thru CR10	Diode, 19330 Same as CR7	19330	
CR11	Diode, 6262	CR0150	
CR12	Diode, 6262	CR0150	
CR13	Diode, 6262	CR0150	
IC1	Integrated Circuit, CA3028A	25702	
IC2	Integrated Circuit, CA3028A	25702	
IC3	Integrated Circuit, CA3028A	25702	
IC4	Integrated Circuit, 4710	19706	
L1	Choke, 2.2μH Wee-Wee	L0078	Nytronics Wee-Wee 2.2
L2	Choke	L0159	Jeffers .05 H 10150-17
L3	Choke	L0159	Jeffers .05 H 10150-17
L4	Choke, 0.15μH	L0080	Stanwyck 1A1503M
L5	Choke, 0.15μH	L0080	Stanwyck 1A1503M
L6	Choke, 100μH	L0073	Stanwyck Dink 100
L7	Choke, 100μH	L0073	Stanwyck Dink 100
L8	Choke, 100μH	L0073	Stanwyck Dink 100
Q1	Transistor, 2N5179	Q0269	
Q2	Transistor, 2N5179	Q0269	
Q3	Transistor, 2N4269	Q0272	
Q4	Transistor, 2N3640	Q0178	
Q5	Transistor, 2N5179	Q0269	
Q6 Thru Q8	Transistor, 2N5179 Same as Q6	Q0269	
Q9	Transistor, 19420	19420	
Q10	Transistor, 19420	19420	
Q11	Transistor, 2N3640	Q0178	
Q12	Transistor, 2N3640	Q0178	
Q13	Transistor, 2N3646	Q0218	
Q14	Transistor, 2N3646	Q0218	

300 MHz Prescaler Parts List (con't.)

Ref.	Description	SD Part No.	Manufacturers Part No.
Q15	Transistor, 2N3640	Q0178	
Q16	Transistor, 2N3646	Q0218	
Q17	Transistor, 2N3646	Q0218	
Q18	Transistor, 2N3640	Q0178	
R1	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R2	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R3	Resistor, 470Ω, 1/4W, 5%	R0743	Allen Bradley CB4705
R4	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R5	Resistor, 39Ω, 1/4W, 5%	R1552	Allen Bradley CB3905
R6	Resistor, 160Ω, 1/4W, 5%	R1572	Allen Bradley CB1615
R7	Resistor, 160Ω, 1/4W, 5%	R1572	Allen Bradley CB1615
R8	Not Used		
R9	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R10	Resistor, 39Ω, 1/4W, 5%	R1552	Allen Bradley CB3905
R11	Resistor, 160Ω, 1/4W, 5%	R1572	Allen Bradley CB1615
R12	Resistor, 160Ω, 1/4W, 5%	R1572	Allen Bradley CB1615
R13	Not Used		
R14	Resistor, 68Ω, 1/4W, 5%	R1426	Allen Bradley CB6805
R15	Resistor, 150Ω, 1/4W, 5%	R0983	Allen Bradley CB1515
R16	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R17	Resistor, 470Ω, 1/4W, 5%	R1044	Allen Bradley CB7415
R18	Resistor, 18Ω, 1/8W, 5%	R1822	Allen Bradley BB1805
R19	Resistor, 33Ω, 1/8W, 5%	R1827	Allen Bradley BB3305
R20	Resistor, 470Ω, 1/4W, 5%	R1044	Allen Bradley CB4715
R21	Resistor, POT, 100	R2374	Beckman Hiltrim 62PR100
R22	Resistor, 12Ω, 1/8W, 5%	R1840	Allen Bradley BB1205
R23	Resistor, 1.5k, 1/4W, 5%	R0783	Allen Bradley CB1525
R24	Resistor, 47Ω, 1/8W, 5%	R1449	Allen Bradley BB4705
R25	Resistor, 39Ω, 1/8W, 5%	R1829	Allen Bradley BB3905
R26	Resistor, 360Ω, 1/4W, 5%	R1571	Allen Bradley CB3615
R27	Resistor, 39Ω, 1/8W, 5%	R1829	Allen Bradley BB3905
R28	Resistor, 1.5k, 1/4W, 5%	R0783	Allen Bradley CB1525
R30	Resistor, 47Ω, 1/8W, 5%	R1449	Allen Bradley BB4705
R31	Resistor, 150Ω, 1/4W, 5%	R0983	Allen Bradley CB1515
R32	Resistor, 39Ω, 1/8W, 5%	R1829	Allen Bradley BB3905
R33	Resistor, 430Ω, 1/4W, 5%	R1667	Allen Bradley CB4315
R34	Resistor, 150Ω, 1/4W, 5%	R0983	Allen Bradley CB1515
R35	Resistor, 39Ω, 1/8W, 5%	R1829	Allen Bradley BB3905

300 MHz Prescaler Parts List (con't.)

Ref.	Description	SD Part No.	Manufacturers Part No.
R36	Resistor, 47Ω, 1/4W, 5%	R0743	Allen Bradley CB4705
R37	Not Used		
R38	Not Used		
R39	Resistor, 47Ω, 1/4W, 5%	R0743	Allen Bradley CB4705
R40	Resistor, 100Ω, 1/4W, 5%	R0966	Allen Bradley CB1025
R41	Resistor, 470Ω, 1/4W, 5%	R1044	Allen Bradley CB4715
R42	Resistor, 47Ω, 1/4W, 5%	R0743	Allen Bradley CB4705
R43	Resistor, 3.3k, 1/4W, 5%	R0742	Allen Bradley CB3325
R44	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R45	Resistor, 100Ω, 1/4W, 5%	R0966	Allen Bradley CB1025
R46	Resistor, 47Ω, 1/4W, 5%	R0743	Allen Bradley CB4705
R47	Resistor, 47Ω, 1/4W, 5%	R0743	Allen Bradley CB4705
R48	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R49	Resistor, POT, 2k	R2307	Mallory MTC-23L4
R50	Resistor, 100Ω, 1/4W, 5%	R0966	Allen Bradley CB1025
R51	Resistor, 1k, 1/4W, 5%	R0743	Allen Bradley CB1025
R52	Resistor, 100Ω, 1/4W, 5%	R0966	Allen Bradley CB1025
R53	Resistor, 120Ω, 1/4W, 5%	R1461	Allen Bradley CB1215
R54	Resistor, 2.2k, 1/4W, 5%	R0749	Allen Bradley CB2225
R55	Resistor, 12k, 1/4W, 5%	R0749	Allen Bradley CB1225
R56	Resistor, 1.8, 1/4W, 5%	R0959	Allen Bradley CB1825
R57	Resistor, 100Ω, 1/4W, 5%	R0966	Allen Bradley CB1025
R58	Resistor, 820Ω, 1/4W, 5%	R0762	Allen Bradley CB8215
R59	Resistor, POT, 500	R2375	Beckman Hiltrim 62PR500
R60	Resistor, 47Ω, 1/4W, 5%	R0743	Allen Bradley CB4705
R61	Resistor, 220Ω, 1/4W, 5%	R0760	Allen Bradley CB2215
R62	Resistor, 220Ω, 1/4W, 5%	R0760	Allen Bradley CB2215
R63	Resistor, 100Ω, 1/8W, 5%	R1441	Allen Bradley BB1025
R64	Resistor, 1k, 1/4W, 5%	R0743	Allen Bradley CB1025

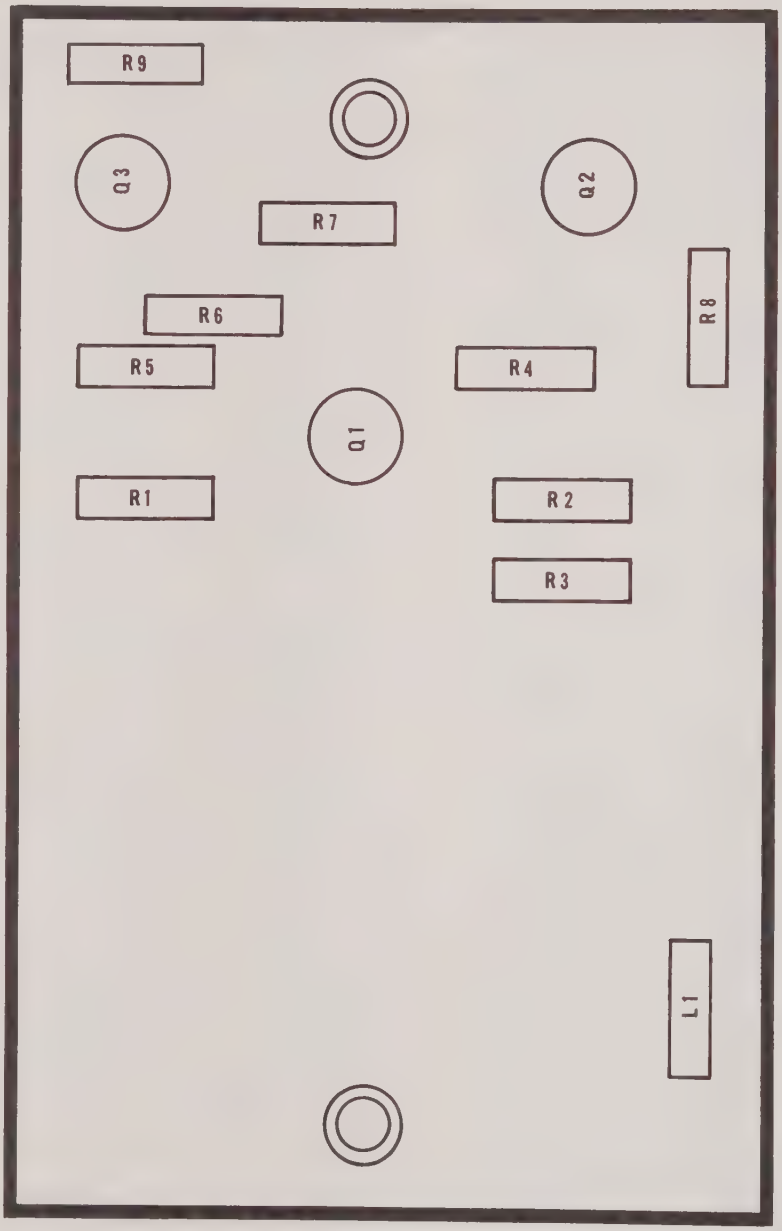


Figure 6-14. 1 MHz (Shaped) Assembly [19943D]

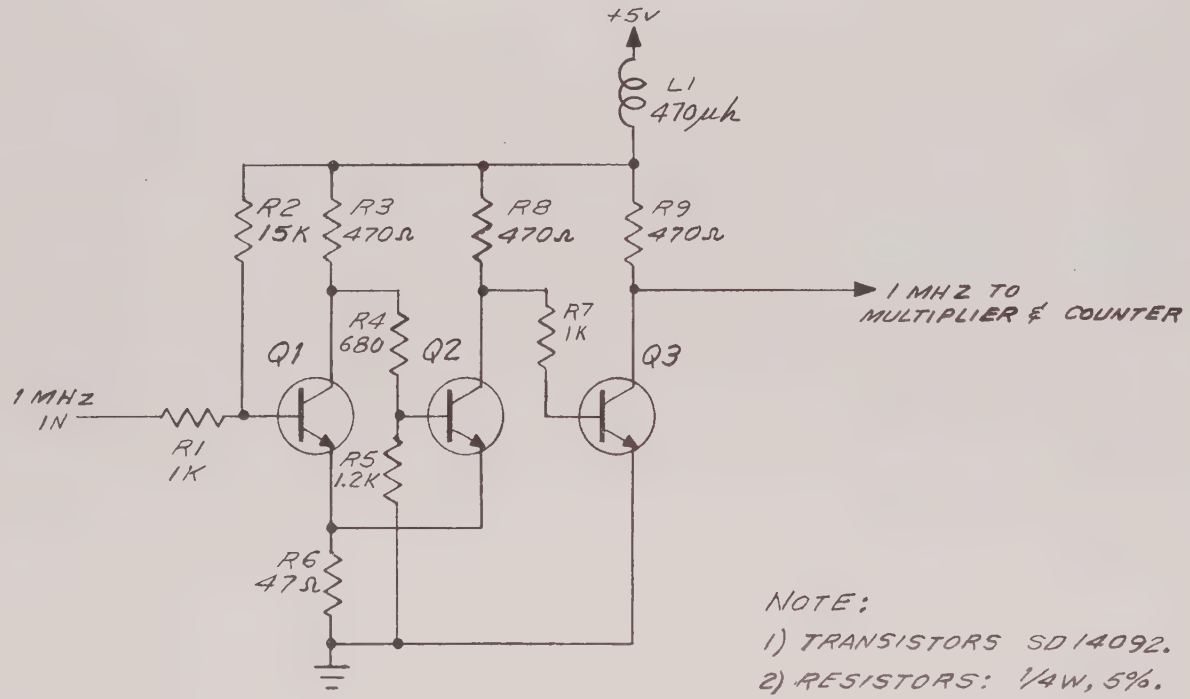


Figure 6-15. Schematic 1 MHz (Shaped) Assembly [23388]

1 MHz P.C. Assembly Parts List

Ref.	Description	SD Part No.	Manufacturers Part No.
	1 MHz P.C. Assembly	19943	
R1	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R2	Resistor, 15k, 1/4W, 5%	R0728	Allen Bradley CB1525
R3	Resistor, 470Ω, 1/4W, 5%	R1044	Allen Bradley CB4715
R4	Resistor, 680Ω, 1/4W, 5%	R1234	Allen Bradley CB6815
R5	Resistor, 1.2k, 1/4W, 5%	R0809	Allen Bradley CB1225
R6	Resistor, 47Ω, 1/4W, 5%	R0743	Allen Bradley CB4705
R7	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R8	Resistor, 470Ω, 1/4W, 5%	R1044	Allen Bradley CB4715
R9	Resistor, 470Ω, 1/4W, 5%	R1044	Allen Bradley CB4715
Q1 Thru	Transistor, 14092	14092	
Q3	Same as Q1		
L1	Choke, 470μH	L0019	Stanwyck Dink 470

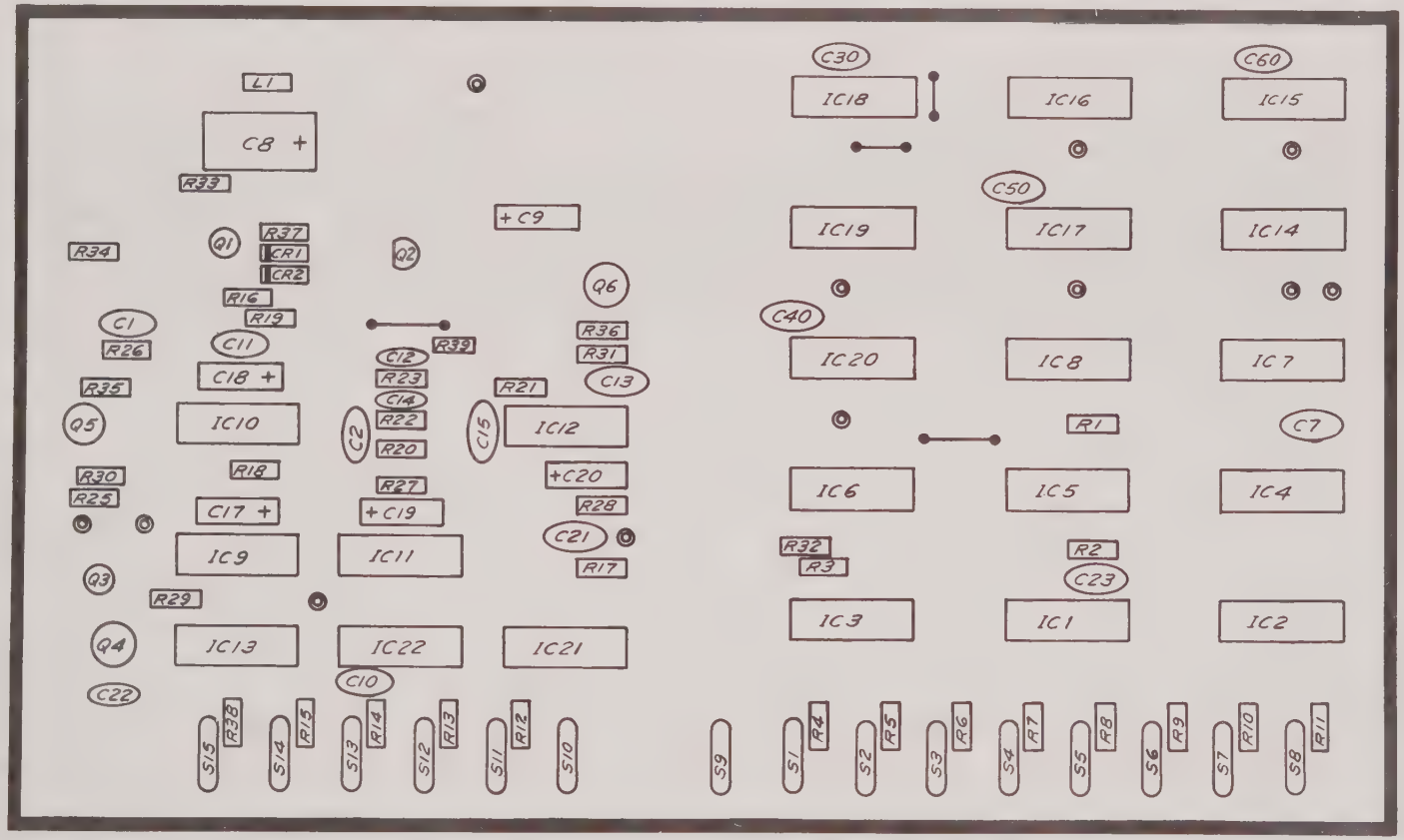


Figure 6-16. Frequency Function [19941C]

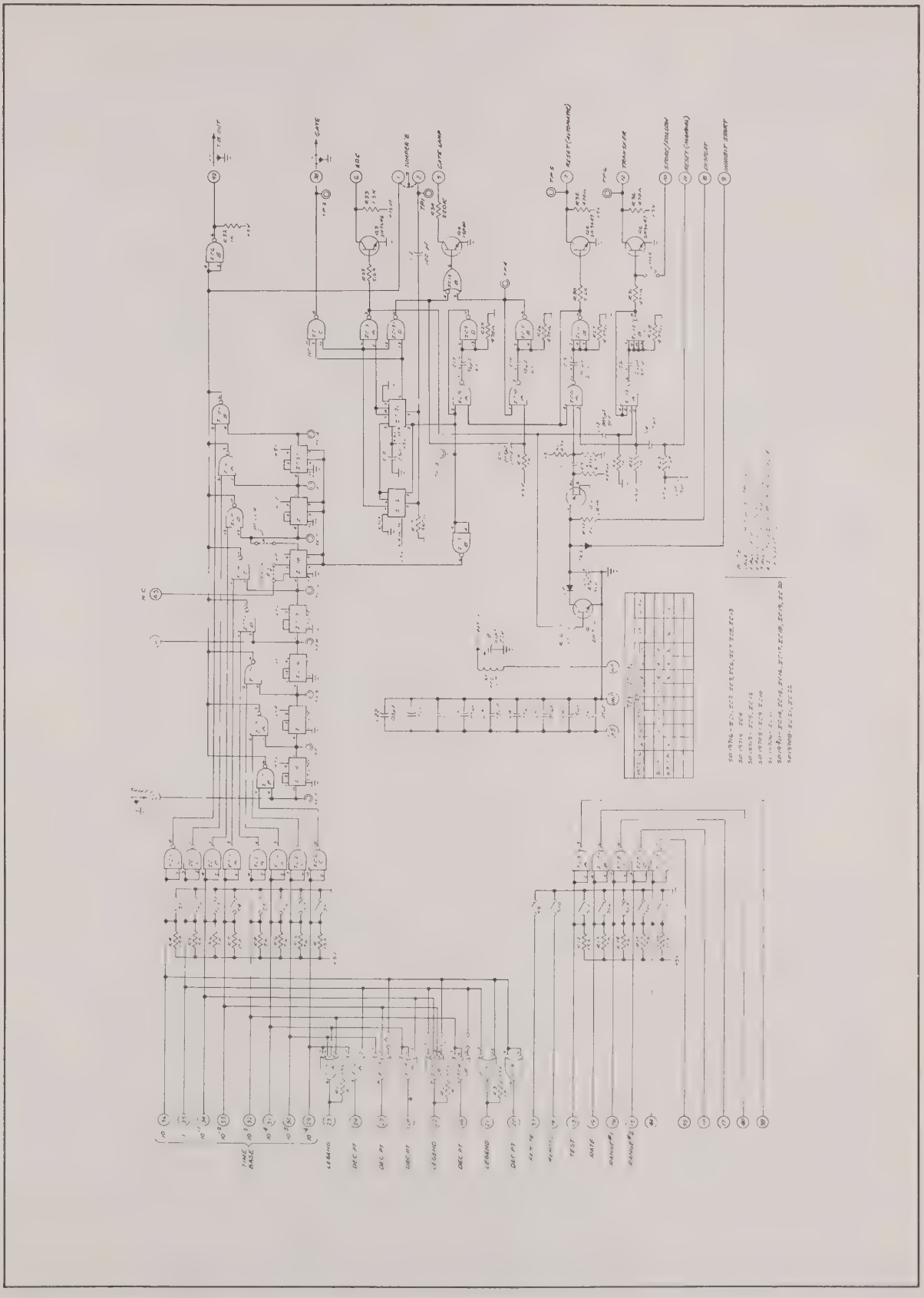


Figure 6-17. Schematic Frequency Function P.C. Assembly [23388]

Frequency Function Parts List

Ref.	Description	SD Part No.	Manufacturers Part No.
	Frequency Function P.C. Assy	19941	
C1	Capacitor, 0.05µF, 12V	C0672	RMC Type M-12
Thru			
C7	Same as C1		
C8	Capacitor, 60µF, 50V	C0783	
C9	Capacitor, 4.7µF, 35V	C0406	Sprague 1500475x003 5B2
C10	Capacitor, 0.05µF, 12V	C0672	RMC Type M-12
C11	Capacitor, 0.005µF, 150V	C0325	Centralab DDM502
Thru			
C13	Same as C11		
C14	Capacitor, 0.05µF, 12V	C0672	RMC Type M-12
C15	Capacitor, 0.05µF, 12V	C0672	RMC Type M-12
C16	Not Used		
C17	Capacitor, 56µF, 6V	C1090	Sprague 1500566x9006B2
C18	Capacitor, 10µF, 6V	C1091	Sprague 1500106x9006B2
C19	Capacitor, 0.10µF, 20V	C0806	
C20	Capacitor, 0.22µF, 35V	C0354	Sprague 1500224x9035A2
C21	Capacitor, 100pF, 500V	C1075	
C22	Capacitor, 0.05µF, 12V	C0672	RMC Type M-12
C23	Capacitor, 0.05µF, 12V	C0672	RMC Type M-12
CR1	Diode, 6262	CR0150	Continental Devices 6262
CR2	Diode, 6262	CR0150	Continental Devices 6262
IC1	Integrated Circuit SD19716	19716	
Thru			
IC4	Same as IC1		
IC5	Integrated Circuit SD19713	19713	
IC6	Integrated Circuit SD19716	19716	
IC7	Integrated Circuit SD19716	19716	
IC8	Integrated Circuit SD19716	19716	
IC9	Integrated Circuit SD19705	19705	
IC10	Integrated Circuit SD19705	19705	
IC11	Integrated Circuit SD19706	19706	
IC12	Integrated Circuit SD19713	19713	
IC13	Integrated Circuit SD19716	19716	
IC14	Integrated Circuit SD19711	19711	
IC15	Integrated Circuit SD19711	19711	

Frequency Function Parts List (con't.)

Ref.	Description	SD Part No.	Manufacturers Part No.
IC16 Thru IC20	Integrated Circuit SD19711 Same as IC16	19711	
IC21	Integrated Circuit SD19708	19708	
IC22	Integrated Circuit SD19708	19708	
L1	Choke, 1000μH	L0068	Stanwyck Dink .15
R1	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R2	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R3	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R4 Thru R15	Resistor, 15k, 1/4W, 5% Same as R1	R0728	Allen Bradley CB1525
R16	Resistor, 5.6k, 1/4W, 5%	R0821	Allen Bradley CB5625
R17	Resistor, 560Ω, 1/4W, 5%	R0819	Allen Bradley CB5615
R18	Resistor, 10k, 1/4W, 5%	R0766	Allen Bradley CB1035
R19	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R20	Resistor, 4.7k, 1/4W, 5%	R0892	Allen Bradley CB7425
R21	Resistor, 10k, 1/4W, 5%	R0766	Allen Bradley CB1035
R22	Resistor, 10k, 1/4W, 5%	R0766	Allen Bradley CB1035
R23	Resistor, 5.6k, 1/4W, 5%	R0821	Allen Bradley CB5625
R24	Resistor		
R25 Thru R28	Resistor, 470Ω, 1/4W, 5% Same as R25	R1044	Allen Bradley CB4715
R29	Resistor, 5.6k, 1/4W, 5%	R0821	Allen Bradley CB5625
R30	Resistor, 5.6k, 1/4W, 5%	R0821	Allen Bradley CB5625
R31	Resistor, 470Ω, 1/4W, 5%	R1044	Allen Bradley CB4715
R32	Resistor, 1k, 1/4W, 5%	R0765	Allen Bradley CB1025
R33	Resistor, 1.5k, 1/4W, 5%	R0783	Allen Bradley CB1525
R34	Resistor, 220k, 1/4W, 5%	R0967	Allen Bradley CB2235
R35	Resistor, 470Ω, 1/4W, 5%	R1044	Allen Bradley CB4715
R36	Resistor, 470Ω, 1/4W, 5%	R1044	Allen Bradley CB4715
R37	Resistor, 10k, 1/4W, 5%	R0766	Allen Bradley CB1035
R38	Resistor, 15k, 1/4W, 5%	R0728	Allen Bradley CB1525
R39	Resistor, 6.8k, 1/4W, 5%	R0696	Allen Bradley CB6825
Q1	Transistor, 2N3565	Q023	
Q2	Transistor, 2N4870	Q0266	

Frequency Function Parts List (con't.)

Ref.	Description	SD Part No.	Manufacturers Part No.
Q3	Transistor, 2N3646	Q0218	
Q4	Transistor, SD15840	15840	
Q5	Transistor, 2N3643	Q0179	
Q6	Transistor, 2N3643	Q0179	
S1 Thru S15	Switch Reed, 19368	19368	
	Same as S1		

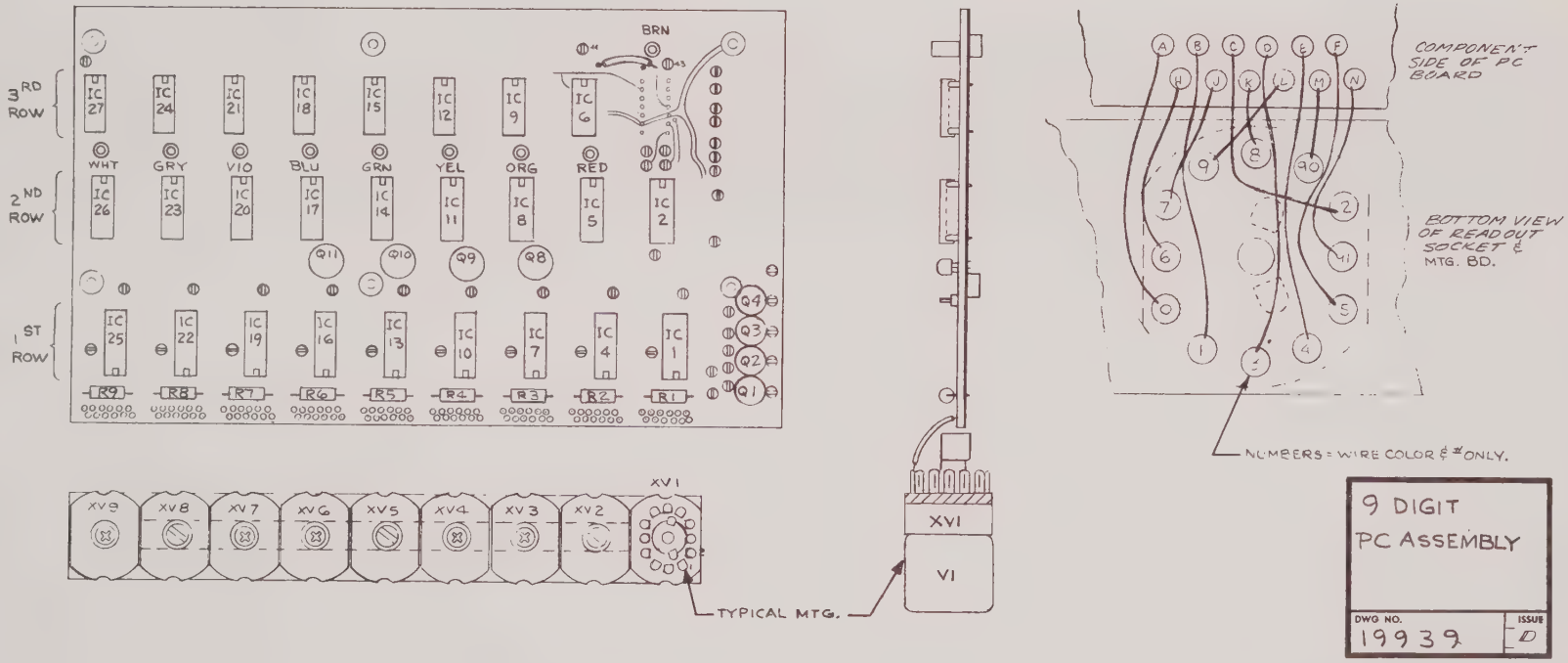


Figure 6-18. 9 Digit P.C. Assembly [19939D]

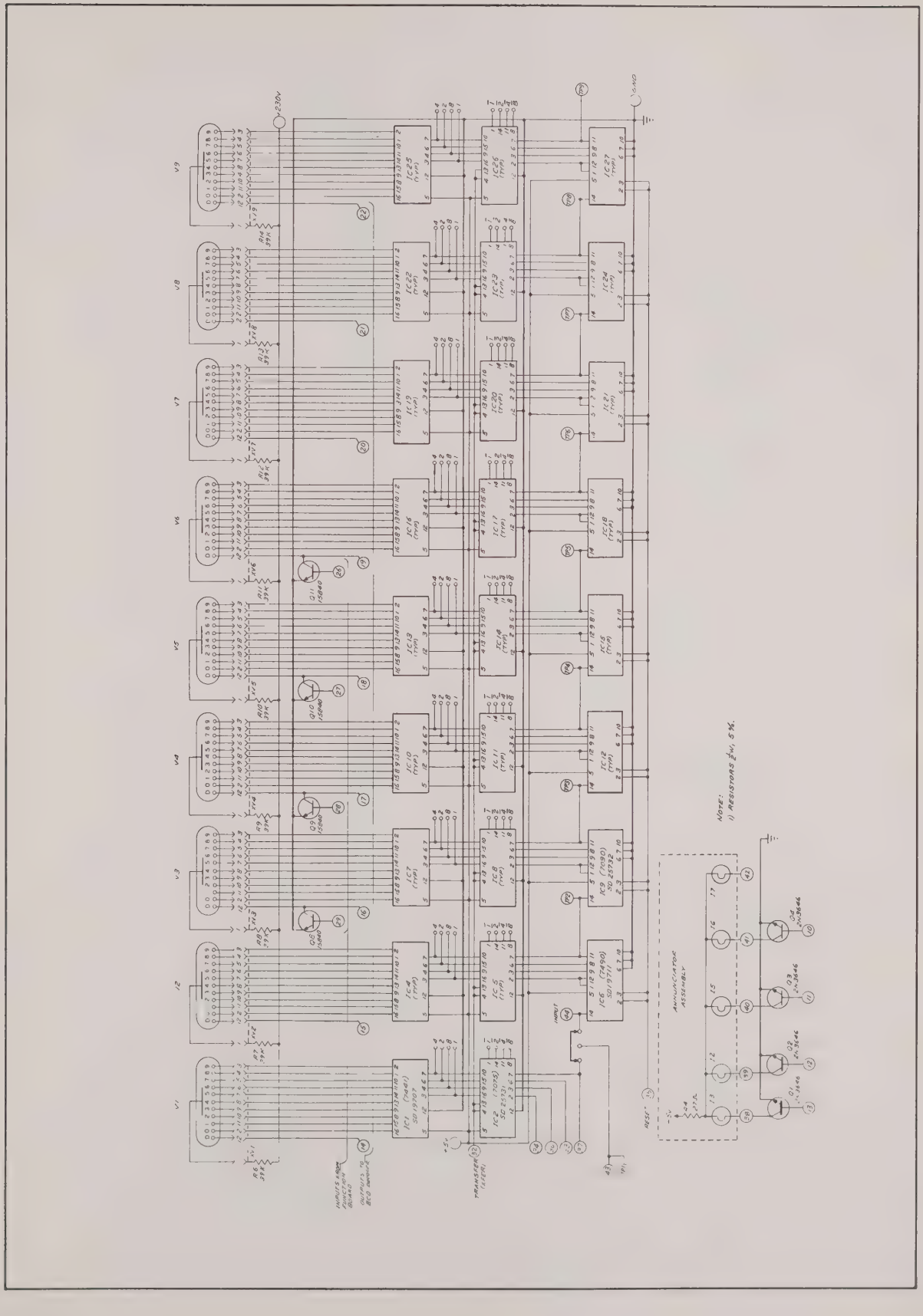


Figure 6-19. Schematic 9 Digit P.C. Assembly [23197D]

9 Digit P.C. Assembly Parts

Ref.	Description	SD Part No.	Manufacturers Part No.
IC1	Integrated Circuit, 7441	19707	
IC2	Integrated Circuit, 7075	25731	
IC3	Not Used		
IC4	Integrated Circuit, 7441	19707	
IC5	Integrated Circuit, 7075	25731	
IC6	Integrated Circuit, 7940	19711	
IC7	Integrated Circuit, 7441	19707	
IC8	Integrated Circuit, 7075	25731	
IC9	Integrated Circuit, 7090	25732	
IC10	Integrated Circuit, 7441	19707	
IC11	Integrated Circuit, 7075	25731	
IC12	Integrated Circuit, 7090	25732	
IC13	Integrated Circuit, 7441	19707	
IC14	Integrated Circuit, 7075	25731	
IC15	Integrated Circuit, 7090	25732	
IC16	Integrated Circuit, 7441	19707	
IC17	Integrated Circuit, 7075	25731	
IC18	Integrated Circuit, 7090	25732	
IC19	Integrated Circuit, 7441	19707	
IC20	Integrated Circuit, 7075	25731	
IC21	Integrated Circuit, 7090	25732	
IC22	Integrated Circuit, 7441	19707	
IC23	Integrated Circuit, 7075	25731	
IC24	Integrated Circuit, 7090	25732	
IC25	Integrated Circuit, 7441	19707	
IC26	Integrated Circuit, 7075	25731	
IC27	Integrated Circuit, 7090	25732	
Q1	Transistor, 2N3646	Q0218	
Thru			
Q4	Same as Q1		
Q5	Not Used		
Q6	Not Used		
Q7	Not Used		
Q8	Transistor, 15840	15840	
Thru			
Q11	Same as Q8		
Q12	Not Used		

9 Digit P.C. Assembly Parts List (con't.)

Ref.	Description	SD Part No.	Manufacturers Part No.
Q13	Not Used		
R1	Resistor, 1/2W, 5%, 39k	R0282	
Thru			
R9	Same as R1		

FINAL ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.	Manufacturers Part No.
C1	Capacitor, .01μF, 150V, Disc	C0233	Centralab DDM103
C2	Capacitor, .01μF, 100V, Disc	C0556	RMC TA110
C3	Capacitor, .01μF, 500V, Disc	C0423	RMC SM Series
C4	Capacitor, .01μF, 500V, Disc	C0423	RMC SM Series
C5	Capacitor, .05μF, 100V, Disc	C0708	Sprague TGS50
C6	Capacitor, .05μF, 100V, Disc	C0708	Sprague TGS50
Z1	Line Filter	Z0001	Comp. Corp. F1060-B
F1	Fuse, 1 Amp, 250V, (Quick)	F0001	Littlefuse 312001
F2	Fuse, 1 Amp, 250V, (Quick)	F0001	Littlefuse 312001
I1	Lamp, Neon	I0074	Edlema BG02-ACS-NE-2H
I2	Lamp, Incandescent	I0050	Chic Min CM8-666
I3	Lamp, Incandescent	I0050	Chic Min CM8-666
I4	Lamp, Incandescent	I0050	Chic Min CM8-666
I5	Not Used		
I6	Lamp, Incandescent	I0050	Chic Min CM8-666
J1	Connector, BNC	J0260	Amphenol UG1094A-U
J2	Connector, Power Splitter	23743	
J3	Connector, BNC	J0165	Star UG1094-U
J4	Connector, BNC	J0165	Star UG1094-U
J5	Not Used		
J6	Not Used		
J7	Not Used		
J8	Not Used		
J9	Connector, BNC	J0260	Amphenol UG1094A-U
R1	Pot & Switch, 5k, SPDT	R2308	Mallory MLC5KMDAC SPDT
R2	Not Used		
R3	Pot & Switch, 2M, SPDT	R2314	Centralab Model 3 B7-1300
R4	Resistor, 27Ω, 1/4W, 5%	R1548	A-B
R5	Resistor, 470Ω, 1/4W, 5%	R1044	A-B
R6	Resistor, 27Ω, 1/4W, 5%	R1548	A-B
S1	Switch, SPDT, (Part of R1)		
S2	Not Used		
S3	Switch, SPDT, (Part of R3)		
S4	Switch, w/Shake	S0160	Greyhill 30-1
S5	Switch, SPDT	S0149	C & K 7101
S6	Switch, Rotary	S0352	Oak DEM 269671-A1
S7	Switch, SPST, 6 Amp	S0328	Mallory ROAC-IA
S8	Switch, DPDT	S0150	C & K 7201

CHAPTER 7

OPTIONS

7.1 INTRODUCTION

This chapter includes description, technical data, and drawings pertaining to the standard options available for this instrument.

7.2 OSCILLATOR OPTIONS

7.2.1 Medium Stability "B3" Oscillator

The "B3" Option provides the instrument with a medium stability oscillator. The "B3" Oscillator has an output frequency of 3 MHz. A divide-by-three circuit has been added, to convert this output frequency to the required 1 MHz frequency reference, along with a separate power supply.

The improved specifications for this oscillator are listed below:

1. Aging rate: ±3 parts in 10^9/24 hours.
2. Warm-up time to reach specified aging rate: 72 hours.
3. Aging rate after 60 days continuous operation: < 3 parts in 10^9/24 hrs.
4. Short term stability averaged over 1 second: ±2 parts in 10^{10} rms.
5. Long-term aging rate: ±2 parts in 10^8/7 days.
6. Variation with temperature (average ±2 parts in 10^{10}/°C): -20°C to +25°C: ±9 parts in 10^9, 25°C 50 55°C: ±6 parts in 10^9.
7. ±10% change in line voltage: ±5 parts in 10^{10}.

The following drawings are a prat of this option and are included at the back of this chapter.

Drawing #25667 B3 option Schematic
25666 B3 option Final Ass'y.
23112 ÷3 1 MHz Schematic
23110 ÷3 1 MHz Assembly

7.2.2 High Stability "B" Oscillator

The "B" Option provides the instrument with a high stability oscillator. The "B" oscillator has an output frequency of 3 MHz. A divide-by-three circuit has been added, to convert this output frequency to the required 1 MHz reference frequency, along with a separate power supply. Thre required specifications for this oscillator are listed below:

Specifications	Option B Oscillator
Aging rate after warnm-up	< ±1 part in 10^8/ 24 hours
Maximum warm-up Frequency retrace for off periods up to approx. 24 hours.	72 hours 1 hour typical to reach ±6 parts in 10^8 max.
Short-term aging rate	±1 part in 10^{10} rms for 1 second average
Temperature variation	< ±2 parts in 10^{10}/ °C, typical (max. ±1 part in 10^9 over 20° change within -20° to +50°C)
10% change in line voltage from specified	±5 parts in 10^{10}
Long-term aging-rate	±3 parts in 10^8/ 30 days

The following drawings are a part of this option and are included at the back of this chapter.

Drawing #25618 B Option Schematic
25601 B Option Final Ass'y
23112 ÷3 1 MHz Schematic
23110 ÷3 1 MHz Assembly
19786 "B Option" Power Supply Assembly

7.2.3 High Stability "B5" Oscillator

The "B5" option provides the instrument with a high stability oscillator. The "B5" oscillator has an output frequency of 3 MHz. A divide-by-three circuit has been added, to convert this output frequency to the required 11 MHz reference frequency, along with a separate power supply and regulator circuit. The improved specifications for the "B5" Oscillator Option are listed below:

Specifications	Option B5 Oscillator
Aging rate after warm-up	±5 parts in 10^{10}/ 24 hours
Maximum warm-up	72 hours
Frequency retrace for off periods up to approx. 24 hours	1 hour typical to reach < ±5 parts in 10^{9}
Short-Term aging rate	±5 parts in 10^{11} for 1 second average
Temperature variation	<±2 parts in 10^{10}/ °C, typical (max. ±1 part in 10^{9} over 20° change within -20° to +50°C)
10% change in line voltage from specified	±5 parts in 10^{1}
Long-term aging rate	±1.5 parts in 10^{8}/ 30 days

The following drawings are a part of this option included at the back of this chapter.

Drawing #27387 B5 Option Schematic
27228 B5 Option Final Ass'y
23112 ÷3 1 MHz Schematic
23110 ÷3 1 MHz Assembly
27217 B5 Regulator Schematic
27220 B5 Regulator Assembly

7.3 BCD OPTIONS

7.3.1 "D1" BCD Option

This option provides the instrument with a 1-2-4-8 BCD output at the rear panel BCD connector. The option uses a positive logic system in which ONE = +15 ±0.5 V, and ZERO = 0.25 ±0.25 V, and is compatible with standard digital recorders. It includes a capacity for 8 digits plus units-of-measure, decimal location, ±reference, print command, inhibit reset, and instrument ground. The print command is a 0 to +15V step occuring at the end of each measurement cycle.

The rear panel BCD connector pin connections are as follows:

Function	BCD	PIN
10^{0}	1	1
	2	2
	4	26
	8	27
10^{1}	1	3
	2	4
	4	28
	8	29
10^{2}	1	5
	2	6
	4	30
	8	31
10^{3}	1	7
	2	8
	4	32
	8	33

Function	BCD	PIN
10^4	1	9
	2	10
	4	34
	8	35
10^5	1	11
	2	12
	4	36
	8	37
10^6	1	13
	2	14
	4	38
	8	39
10^7	1	15
	2	16
	4	40
	8	41
MU	1	17
	2	18
	4	42
	8	43
DP	1	19
	2	20
	4	44
	8	45
+ REF	25	(+12V)
- REF	24	(+3V)
GND	50	
Print Com.	23	
Inhibit Reset	47	

BCD MU Translation
GHz = Binary 1
MHz = Binary 2
kHz = Binary 3

The following drawings are a part of this option, and are included at the back of this chapter.
Drawing #23454 D1 Option Schematic
23874 D1 Option Assembly

7.3.2 "D3" BCD Option

This option provides the instrument with a 1-2-4-8 BCD output at the rear panel BCD connector. The option uses a positive logic system in which ONE = +5 ±0.5V, and ZERO = 0.25 ±0.25V, and is compatible with DTL, TTL, and RTL logic systems. It includes a capacity for 8 digits, plug units-of-measure, Decimal location, ± reference, print command, inhibit reset, and instrument ground. The print command is a 0 to +5V step occuring at the end of each measurement cycle.

The rear panel BCD connector pin connections are as follows:

Function	BCD	PIN
10^0	1	1
	2	2
	4	26
	8	27
10^1	1	3
	2	4
	4	28
	8	29
10^2	1	5
	2	6
	4	30
	8	31
10^3	1	7
	3	8
	4	32
	8	33
10^4	1	9
	2	10
	4	34
	8	35
10^5	1	11
	2	12
	4	36
	8	37

Function	BCD	PIN
10^6	1	13
	2	14
	4	38
	8	39
10^7	1	15
	2	16
	4	40
	8	41
MU	1	17
	2	18
	4	42
	8	43 (GND)

Function	BCD	PIN
DP	1	19
	2	20
	4	44
	8	45
+ Reference	25	+4V
- Reference	24	+1V
Print Command	24	(positive)
Print Command	48	(negative)
Reset Inhibit	47	

BCD MU Translation
GHz = Binary 1
MHz = Binary 2
kHz = Binary 3

The following drawings are a part of this option, and are included in the back of this chapter:

Drawing #S29436 D3 Option Schematic
S29592 Decoder Diode Schematic
S29439 D3 Option PC Assembly

7.4 REMOTE CONTROL "P" OPTION

This option provides for single line remote control of the instrument's RESOLUTION and RANGE functions, through the rear panel REMOTE connector J8.

The following is a listing of the control function, the Frequency Function Board connection, and the J8 connector pin.

Control Switch	Control Function	Frequency Function Board	Remote Control J8
RANGE	Remote Gnd.	14	1
	Test	13	2
	Rate	19	3
	Prescaler	15	4
	Range #1	16	5
	Range #2	44	6
RESOLUTION	Remote Gnd.	37	10
	10^{-6}	29	11
	10^{-5}	30	13
	10^{-4}	31	14
	10^{-3}	32	15
	10^{-2}	33	16
	10^{-1}	34	17
	1	35	18
	10	36	19
	Instrument Gnd.		30
	Remote Reset	11	36

7.5 REAR PANEL INPUT CONNECTORS, "R1" OPTION

This option provides rear panel connectors in parallel with the front panel 0-.1 GHz connector no other circuit changes are involved. Input circuit capacity is increased by about 50 pF.

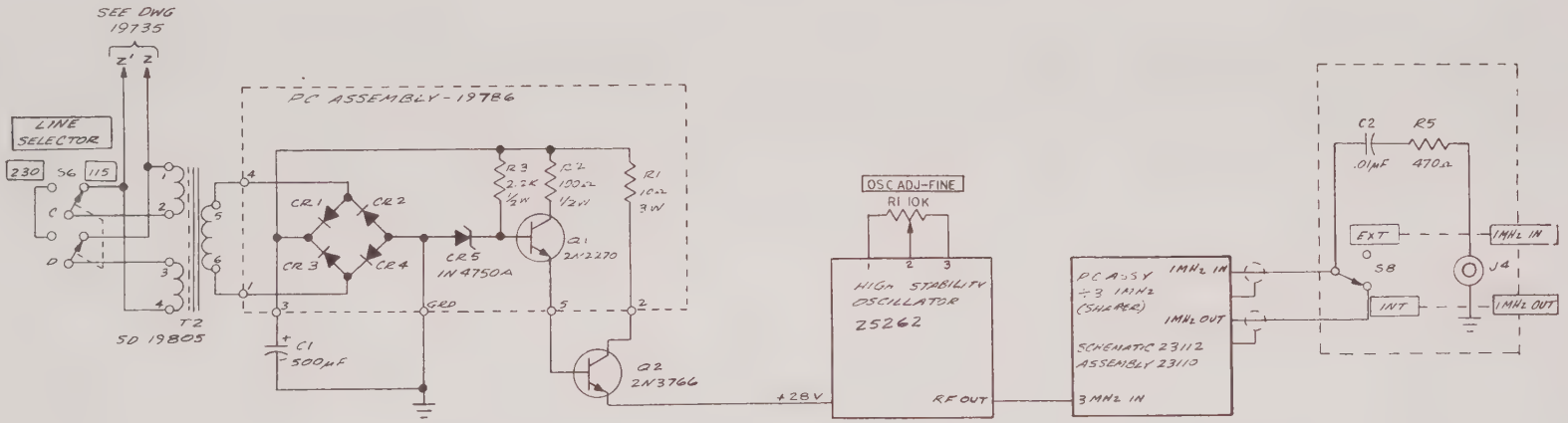


Figure 7-1. B3 Option Schematic (25667)

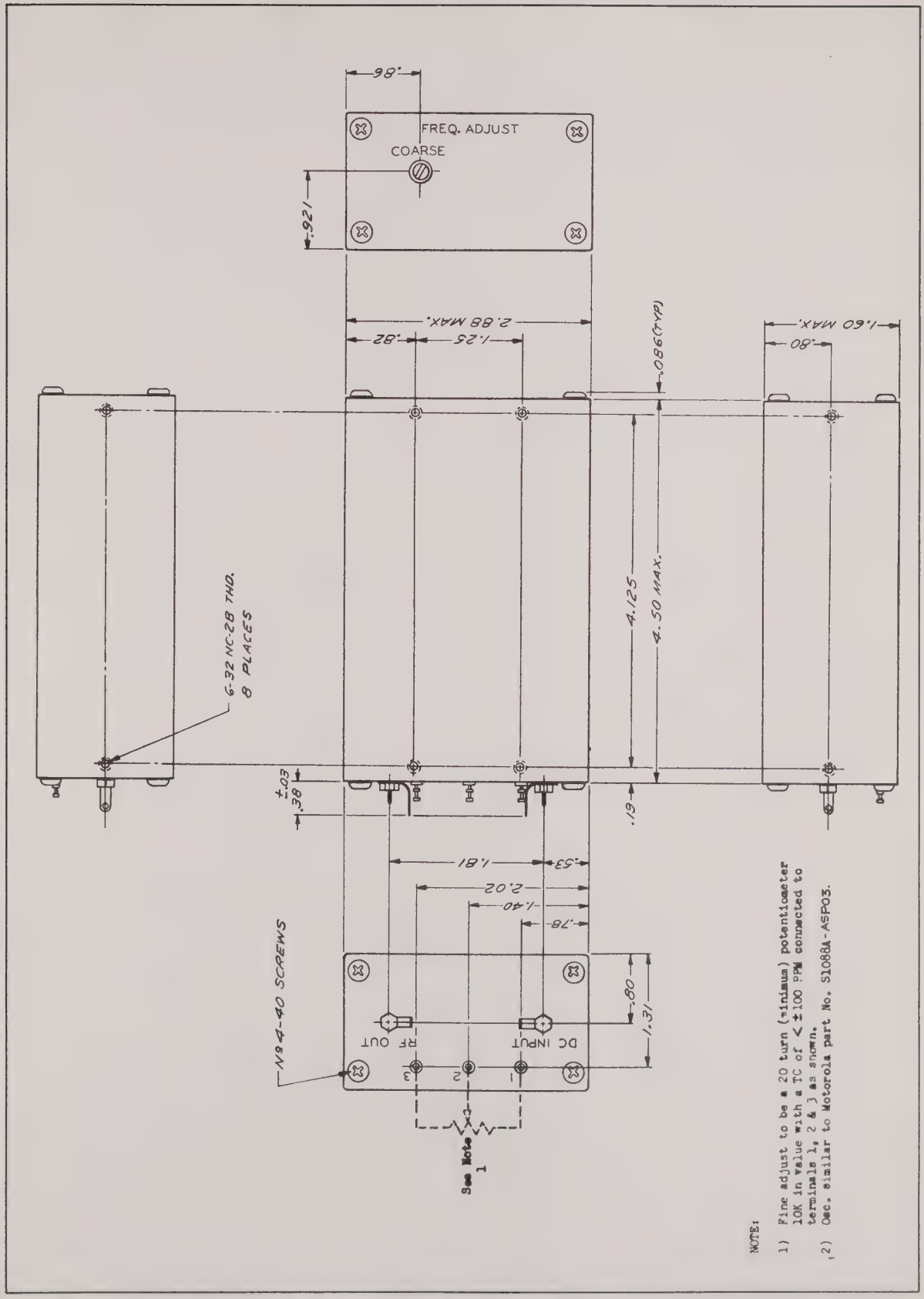


Figure 7-2. B3 High Stability Oscillator Assembly (25262)

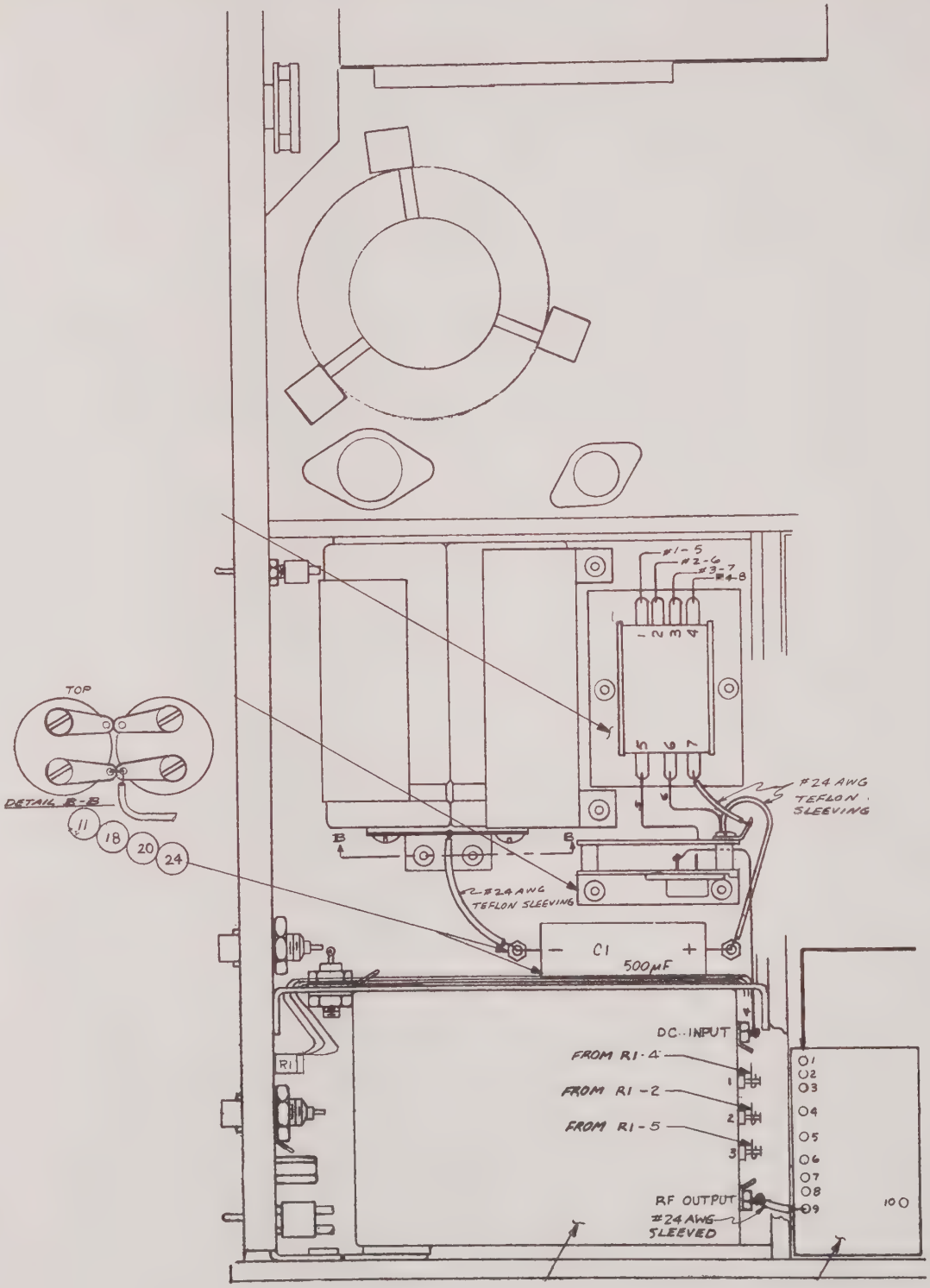


Figure 7-3. B3 Final Assembly (25666)

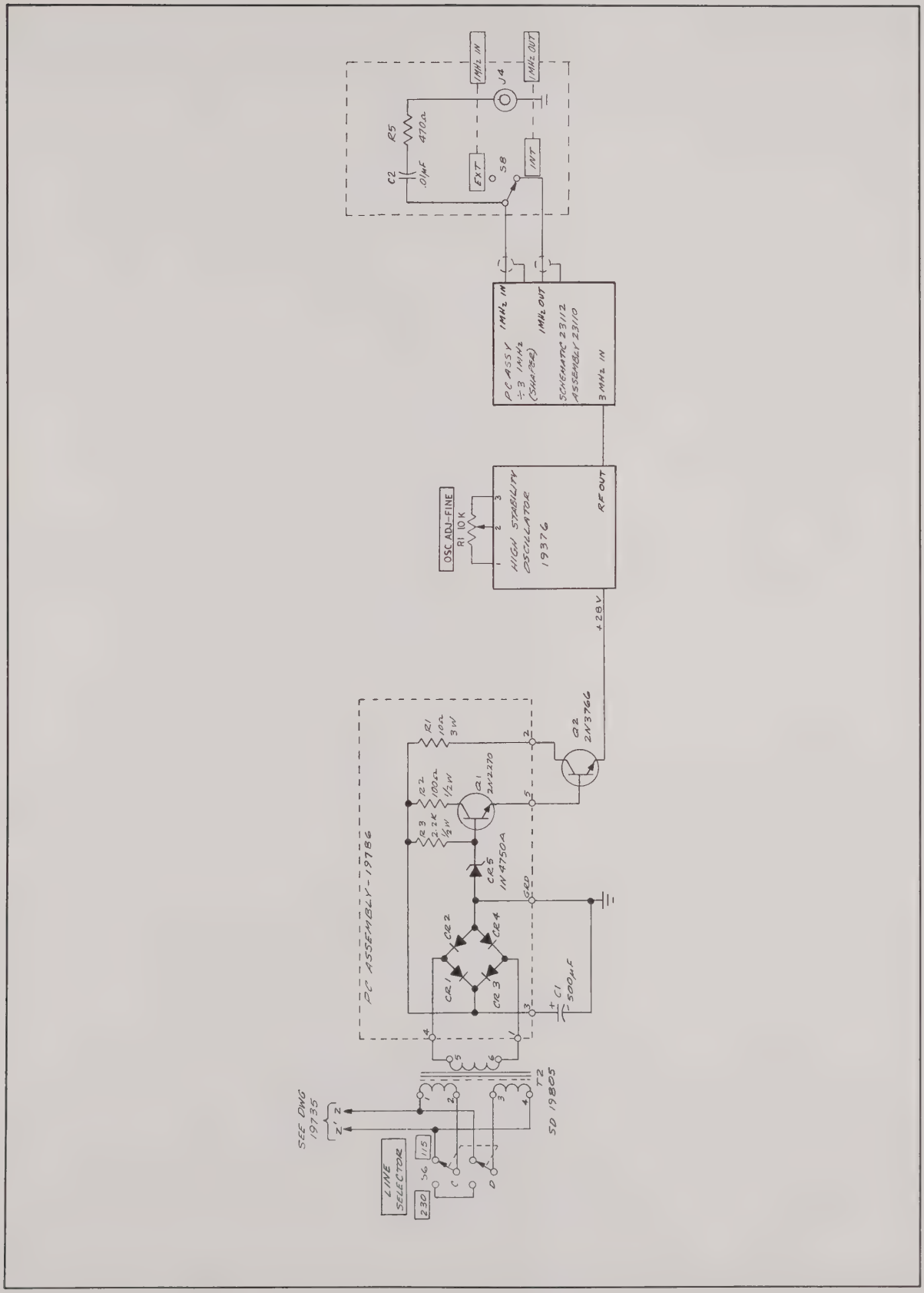


Figure 7-4. B Option Schematic (25618)

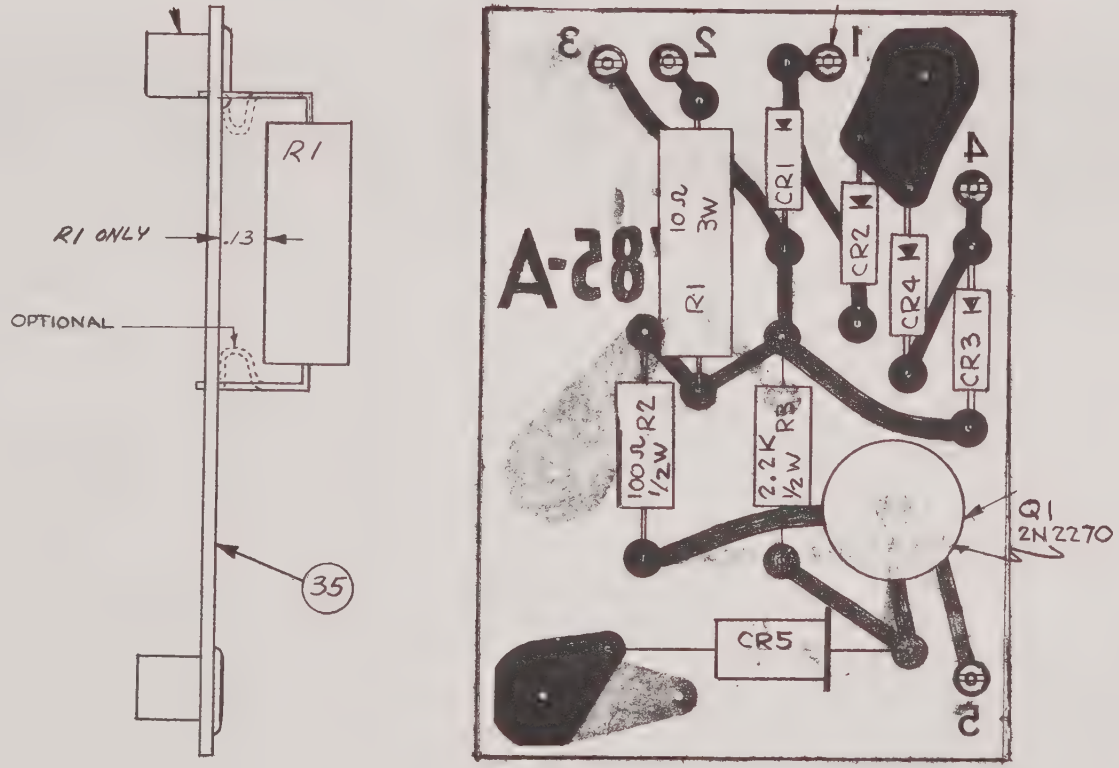
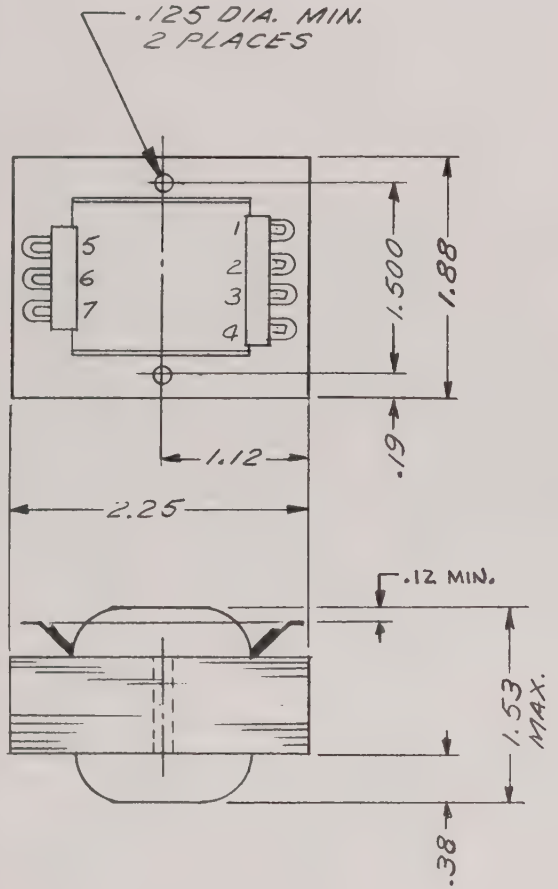


Figure 7-5. B Option Power Supply Assembly (19786)



TRANSFORMER SPECIFICATION

MECHANICAL:		E-I construction lug terminations as shown. 70°C ambient maximum 40°C rise (continuous) See below 60°C rise (transient)
Primary:		117V (105-130V) 50-400 cps 234V (210-260V) electrostatically shielded (4 terminals)
Start:	pin 1	
Finish:	pin 2	
Start:	pin 3	
Finish:	pin 4	
Shield:	pin 7	
Secondary:		33.5 V_{RMS} ± 5% (no load) .7 Ω maximum, 4 Ω minimum* loading = 0.18 A_{RMS} 40°C rise = 0.61 A_{RMS} 60°C rise
Start:	pin 5	
Finish:	pin 6	
		*Resistance values are $r_s + a^2 r_p$ @ 25°C ambient (across full secondary).
Marking:		Transformer shall be marked 19805-B plus the manufacturer's name or trademark. Terminals marked as shown.

Figure 7-6. B Option Transformer (19805)

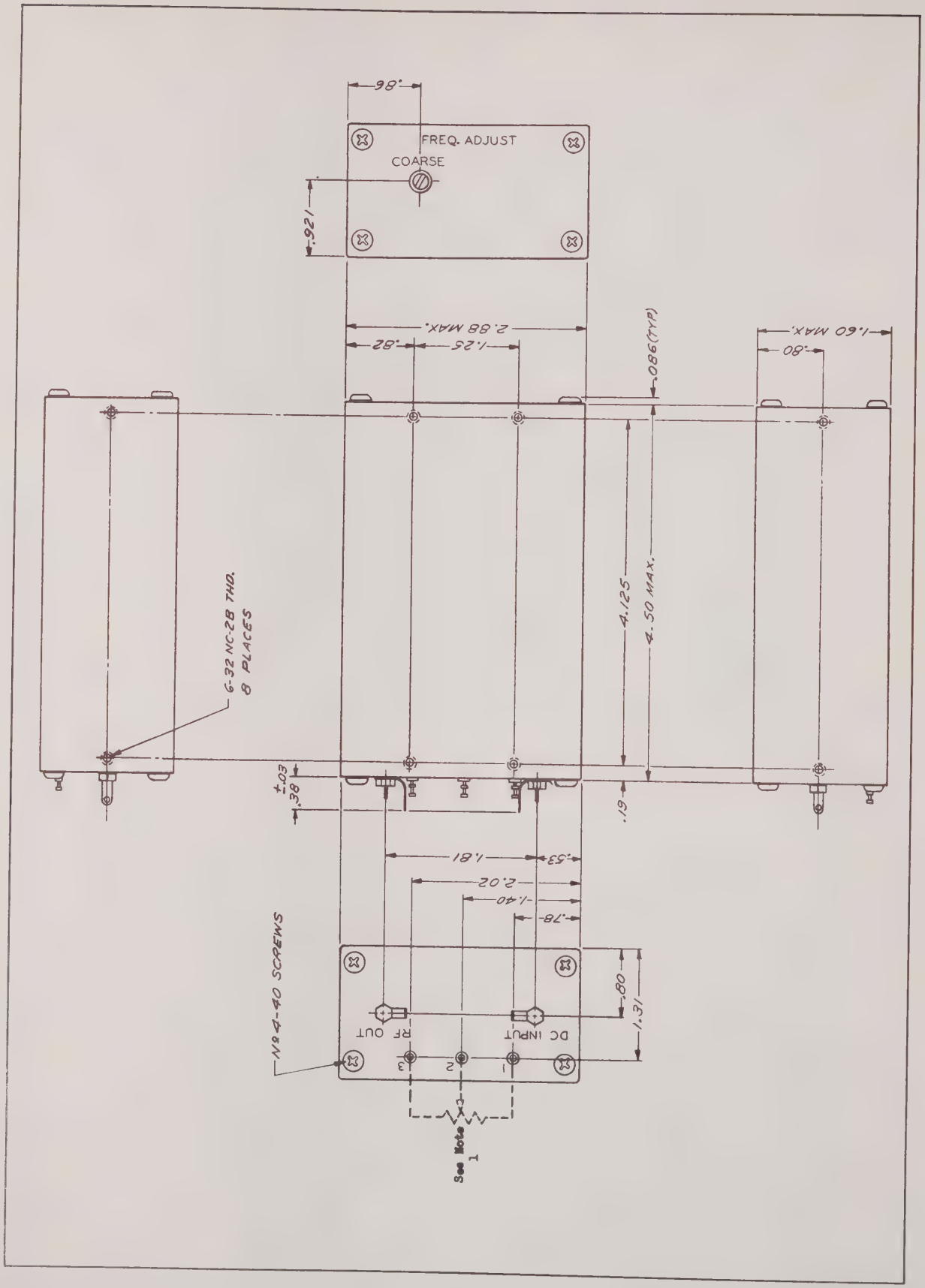


Figure 7-7. B High Stability Oscillator (19376)

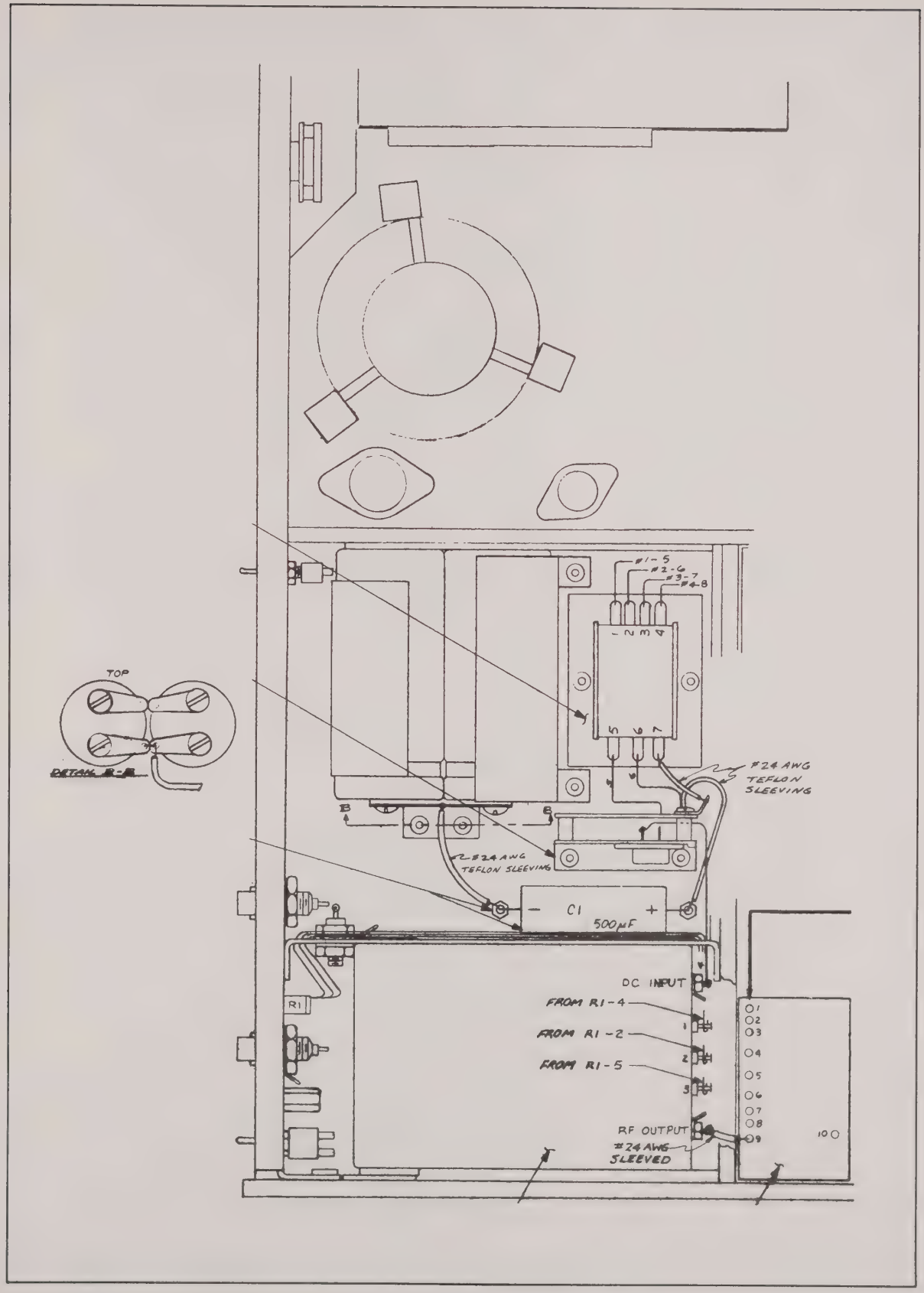


Figure 7-8. B Option Final Assembly (25610)

B Option Power Supply P.C. Assembly Parts List

Ref.	Description	SD Part No.	Manufacturers Part No.
	Schematic	19783	
CR1 Thru CR4	Diode, DI-52 / Same as CR1	CR0148	
CR5	Diode, Zener IN3030A, 1W, 5%, 27V	CR0224	
Q1	Transistor, 2N2270	Q0102	
R1	Resistor, 10Ω, 3W Sprague	R2301	
R2	Resistor, 100Ω, 1/2W, 5%	R0466	
R3	Resistor, 2.2k, 1/2W, 5%	R0259	

B Option Final Assembly Parts List

Ref.	Description	SD Part No.	Manufacturers Part No.
C1	Capacitor, 500μF, 50V	C1087	
R1	Resistor, 10k, POT	R2392	
T2	Transformer "B" Option Spec.	19805	
	Delete Socket, 8 Pin Octal	X0004	

B3 Option Final Assembly Parts List

Ref.	Description	SD Part No.	Manufacturers Part No.
C1	Capacitor, 500μF, 50V	C1087	
R1	Resistor, 10k, POT	R2392	
T2	Transformer "B" Option Spec	19805	

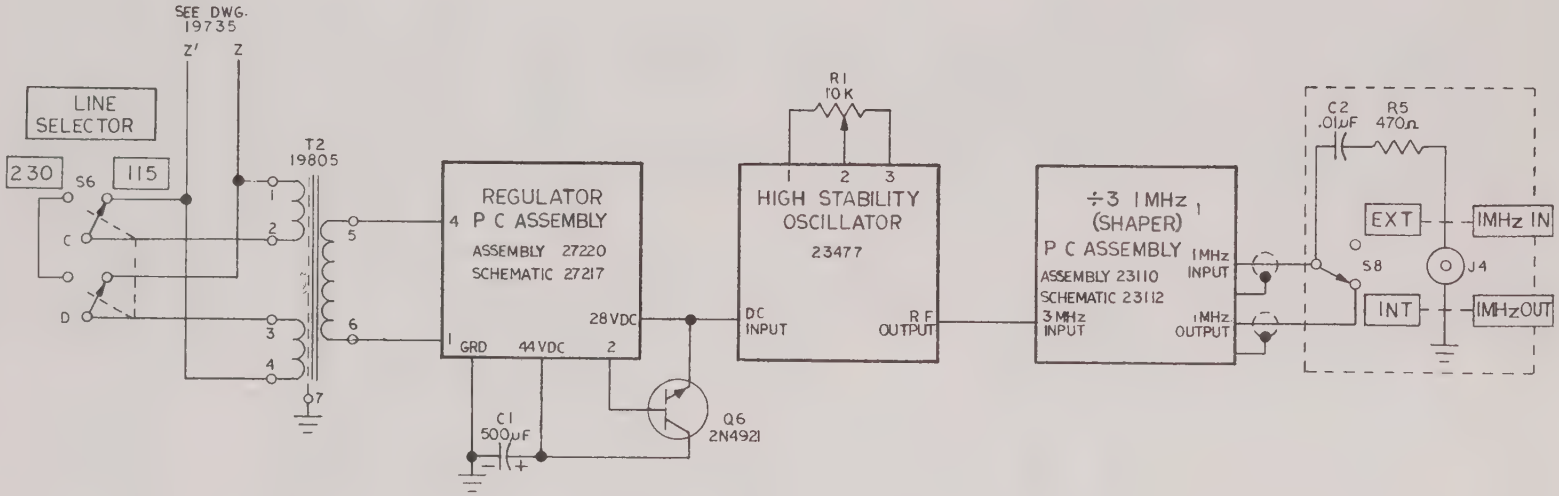


Figure 7-9. B5 Option Schematic (27387)

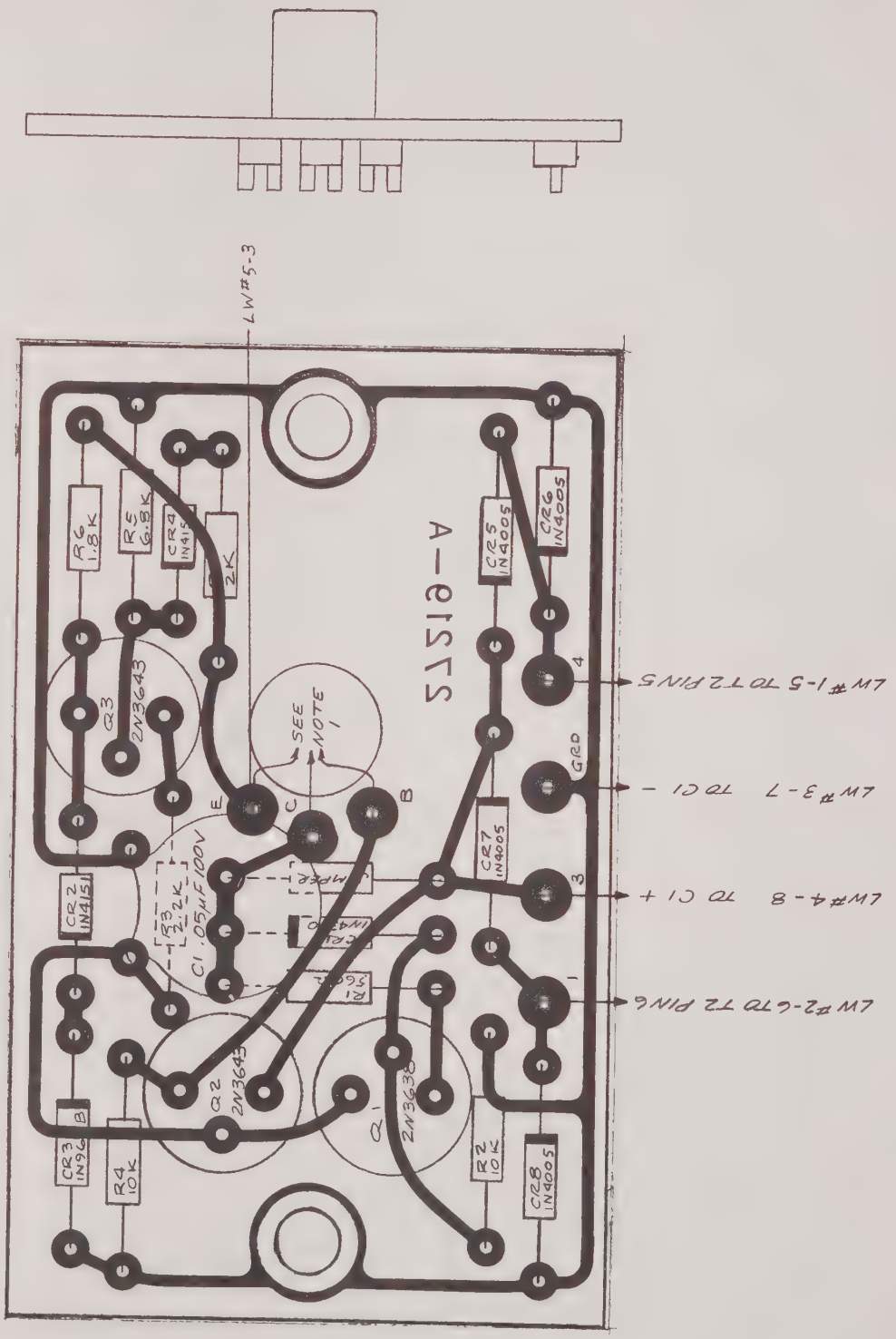
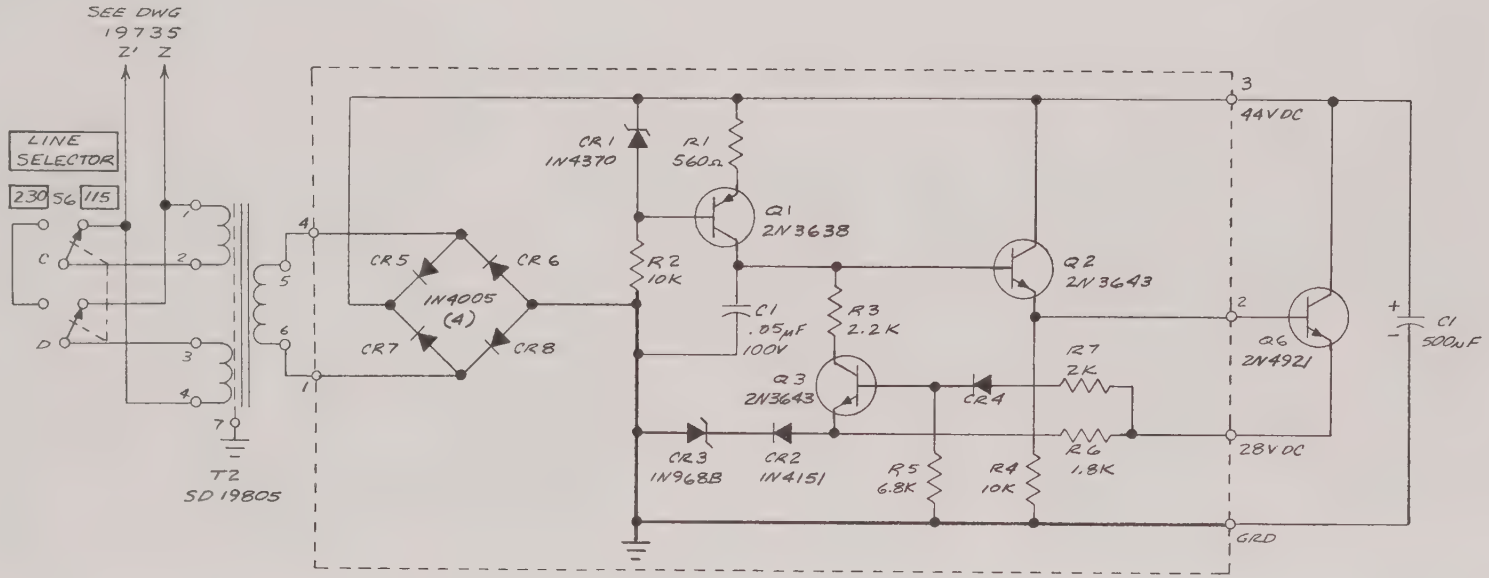


Figure 7-10. B5 Regulator Assembly (27720)



NOTE:

1. ALL RESISTORS 1/4W, ±5%.

Figure 7-11. B5 Regulator Schematic (27217)

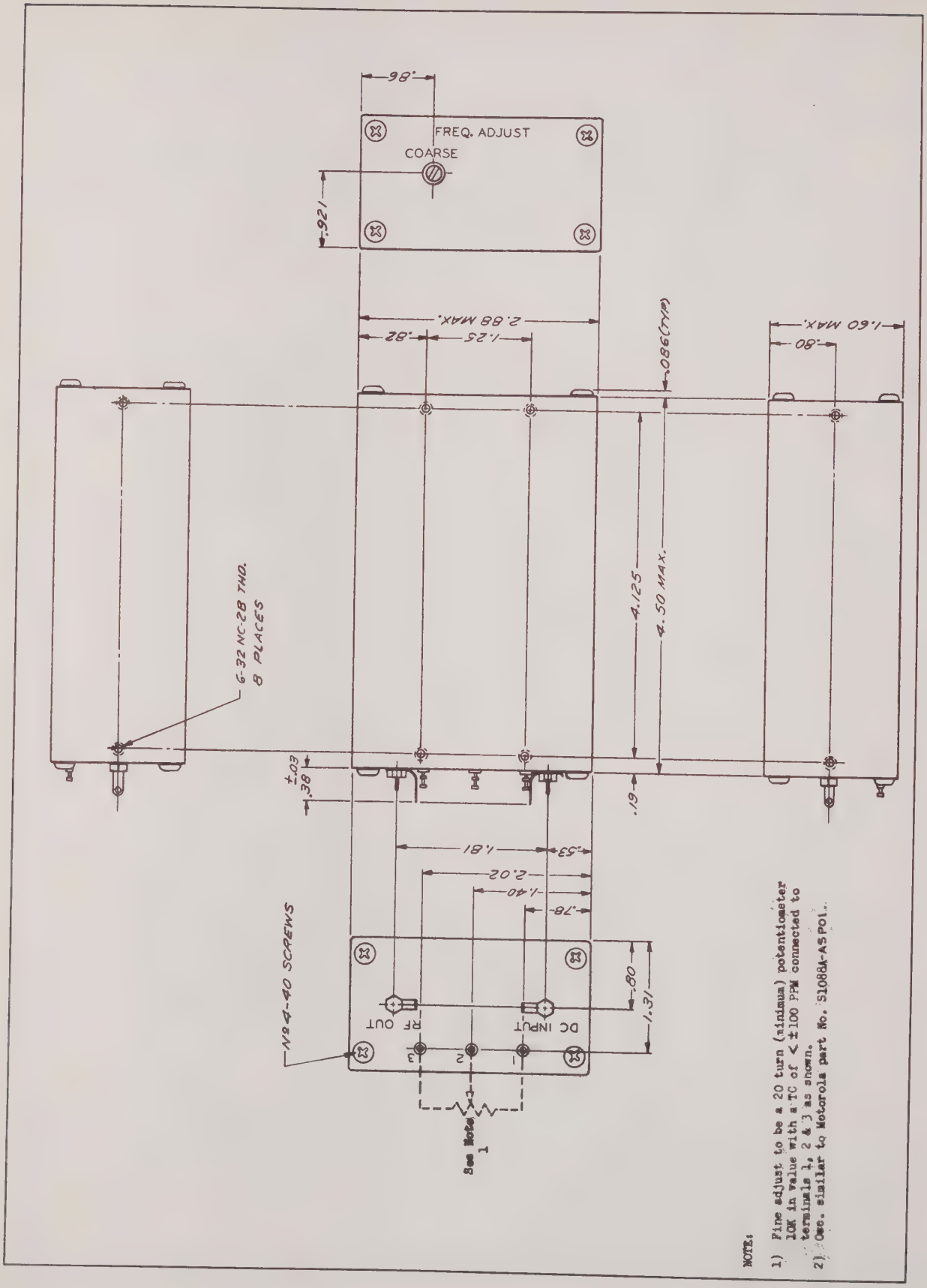


Figure 7-12. B5 High Stability Oscillator (23477)

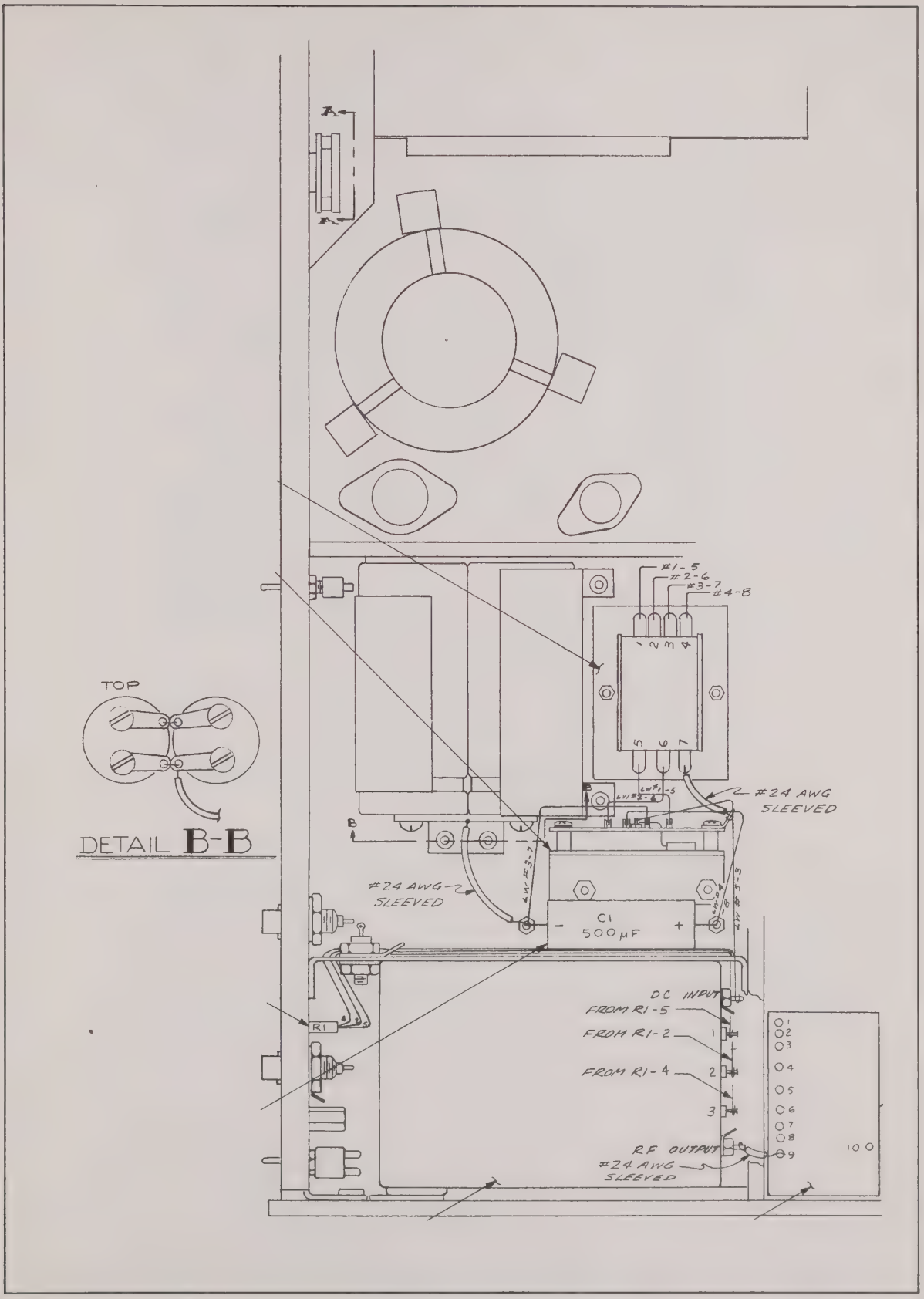


Figure 7-13. B5 Option Final Assembly (27228)

B5 Regulator P.C. Assembly Parts List

Ref.	Description	SD Part No.	Manufacturers Part No.
	Schematic	27217	
C1	Capacitor, .05, 50V, Disc.	C0708	
CR1	Diode, IN4370	CR0309	
CR2	Diode, IN4151	CR0150	
CR3	Diode, IN968B	CR0265	
CR4	Diode, IN4151	CR0150	
CR5	Diode, IN4005	CR0284	
CR6	Diode, IN4005	CR0284	
CR7	Diode, IN4005	CR0284	
CR8	Diode, IN4005	CR0284	
Q1	Transistor, 2N3638	Q0181	
Q2	Transistor, 2N3643	Q0179	
Q3	Transistor, 2N3643	Q0179	
R1	Resistor, 560Ω, 1/4W, 5%	R0819	
R2	Resistor, 10k, 1/4W, 5%	R0766	
R3	Resistor, 2.2k, 1/4W, 5%	R0749	
R4	Resistor, 10k, 1/4W, 5%	R0766	
R5	Resistor, 6.8k, 1/4W, 5%	R0696	
R6	Resistor, 1.8k, 1/4W, 5%	R0959	
R7	Resistor, 2k, 1/4W, 5%	R0734	

B5 Option Final Assembly Parts List

Ref.	Description	SD Part No.	Manufacturers Part No.
C1	Capacitor, 500μF, 50V	C1087	
R1	Resistor, 10k, POT	R2392	
T2	Transformer	19805	
	Delete Socket, 8 Pin Octal	X0004	

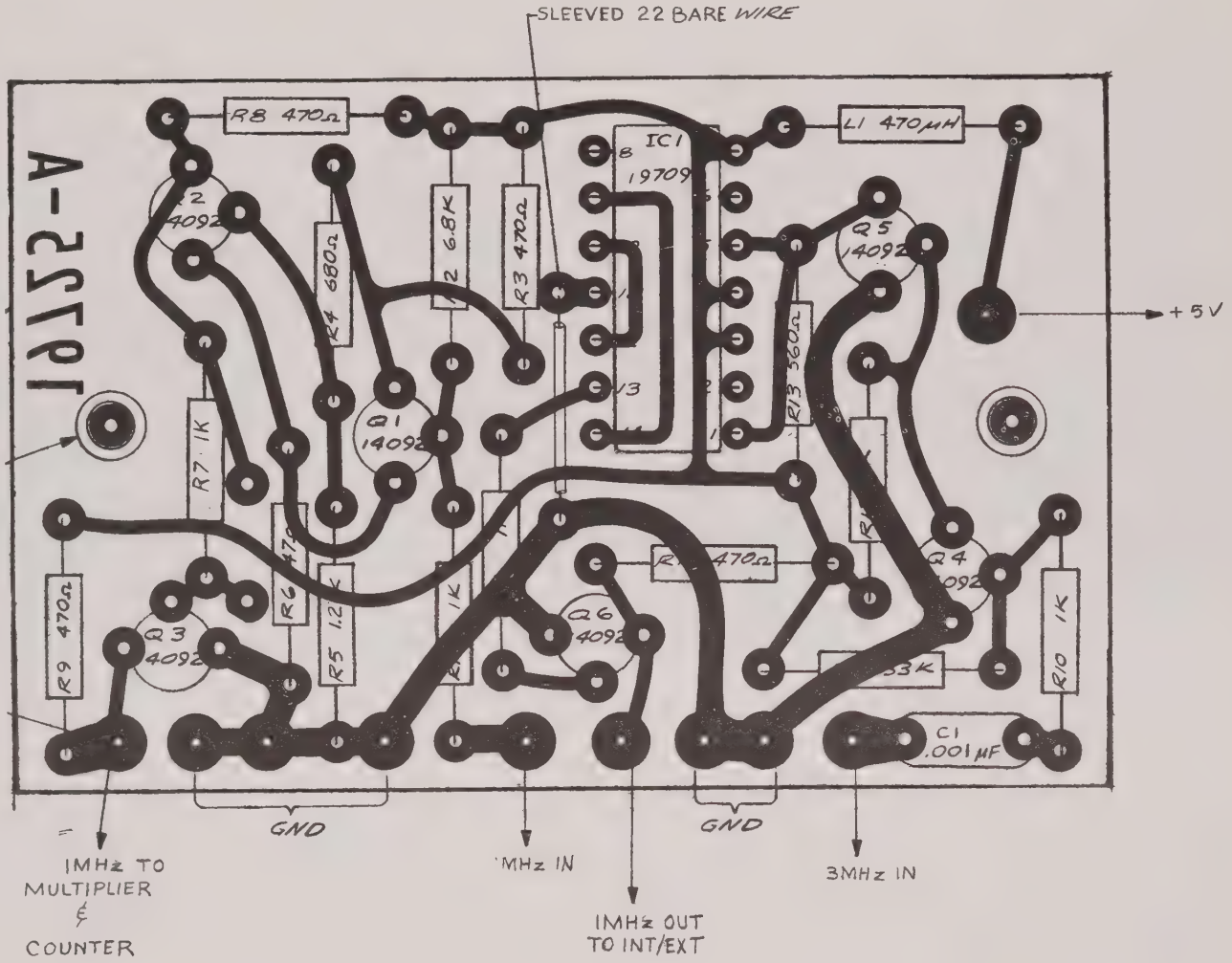
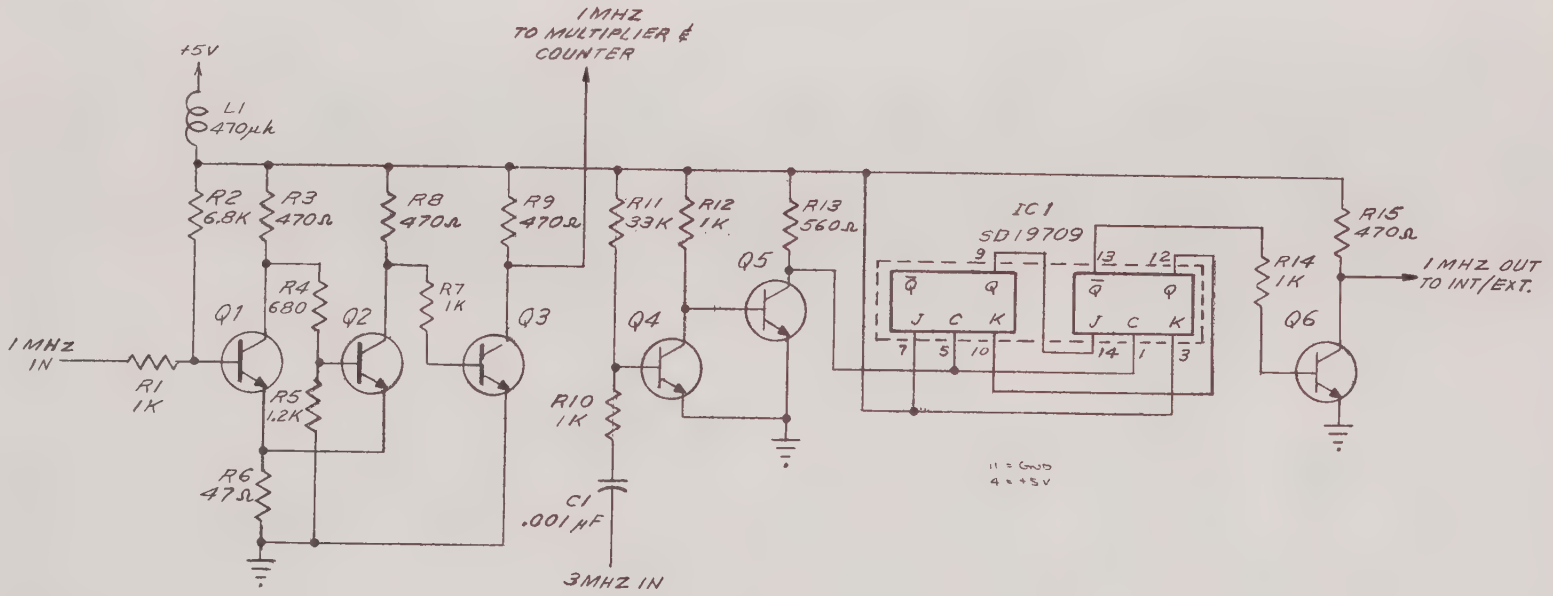


Figure 7-14. %3 1 MHz P.C. Assembly (23110)



NOTE:
1) TRANSISTORS SD14092.
2) RESISTORS: 1/4W, 5%.

Figure 7-15. %3 1 MHz P.C. Schematic (23112)

:3 1 MHz P.C. Assembly Parts List

Ref.	Description	SD Part No.	Manufacturers Part No.
	Schematic	23112	
C1	Capacitor, .001μF, 500V Disc.	C0424	
IC1	Integrated Circuit, SD19709	19709	
L1	Choke, 470μH	L0019	
R1	Resistor, 1k, 1/4W, 5%	R0765	
R2	Resistor, 6.8k, 1/4W, 5%	R0696	
R3	Resistor, 470Ω, 1/4W, 5%	R1044	
R4	Resistor, 680Ω, 1/4W, 5%	R1234	
R5	Resistor, 1.2k, 1/4W, 5%	R0809	
R6	Resistor, 47Ω, 1/4W, 5%	R0743	
R7	Resistor, 1k, 1/4W, 5%	R0765	
R8	Resistor, 470Ω, 1/4W, 5%	R1044	
R9	Resistor, 470Ω, 1/4W, 5%	R1044	
R10	Resistor, 1k, 1/4W, 5%	R0765	
R11	Resistor, 33k, 1/4W, 5%	R0780	
R12	Resistor, 1k, 1/4W, 5%	R0780	
R13	Resistor, 560Ω, 1/4W, 5%	R0819	
R14	Resistor, 1k, 1/4W, 5%	R0780	
R15	Resistor, 470Ω, 1/4W, 5%	R1044	
	Terminal	E0100	

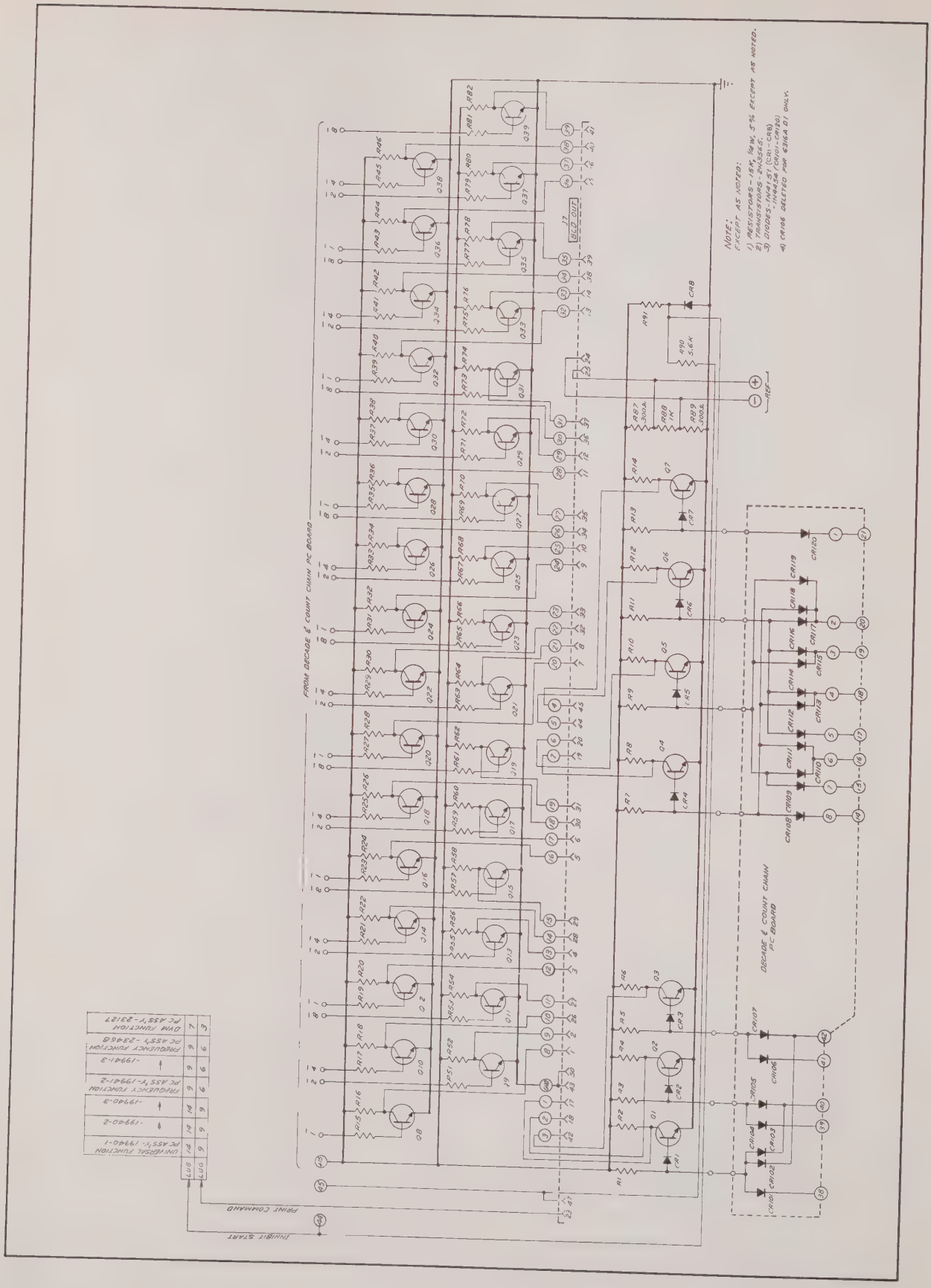


Figure 7-16. D1 Option Schematic (23454)

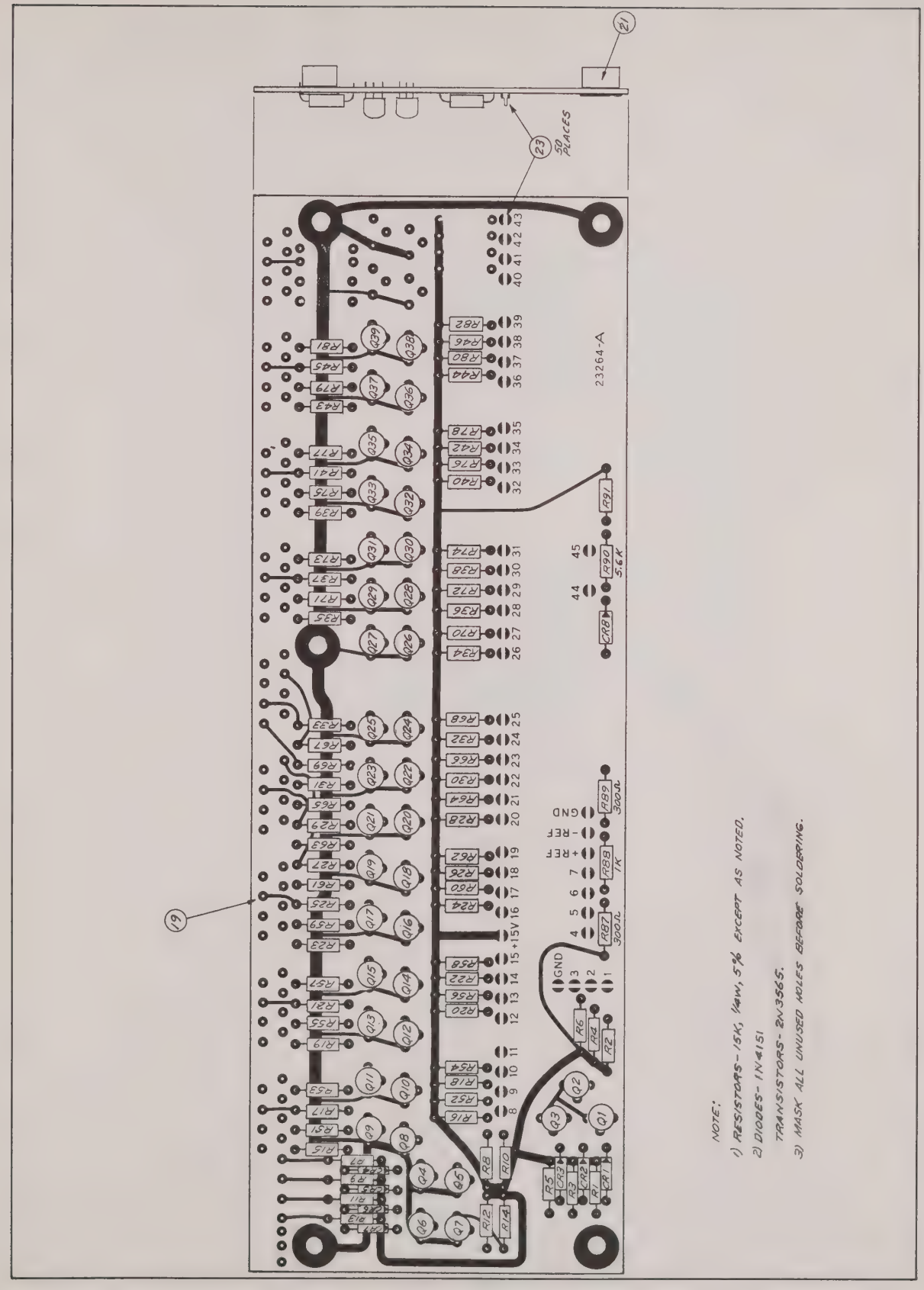


Figure 7-17. D1 Option Assembly (23874)

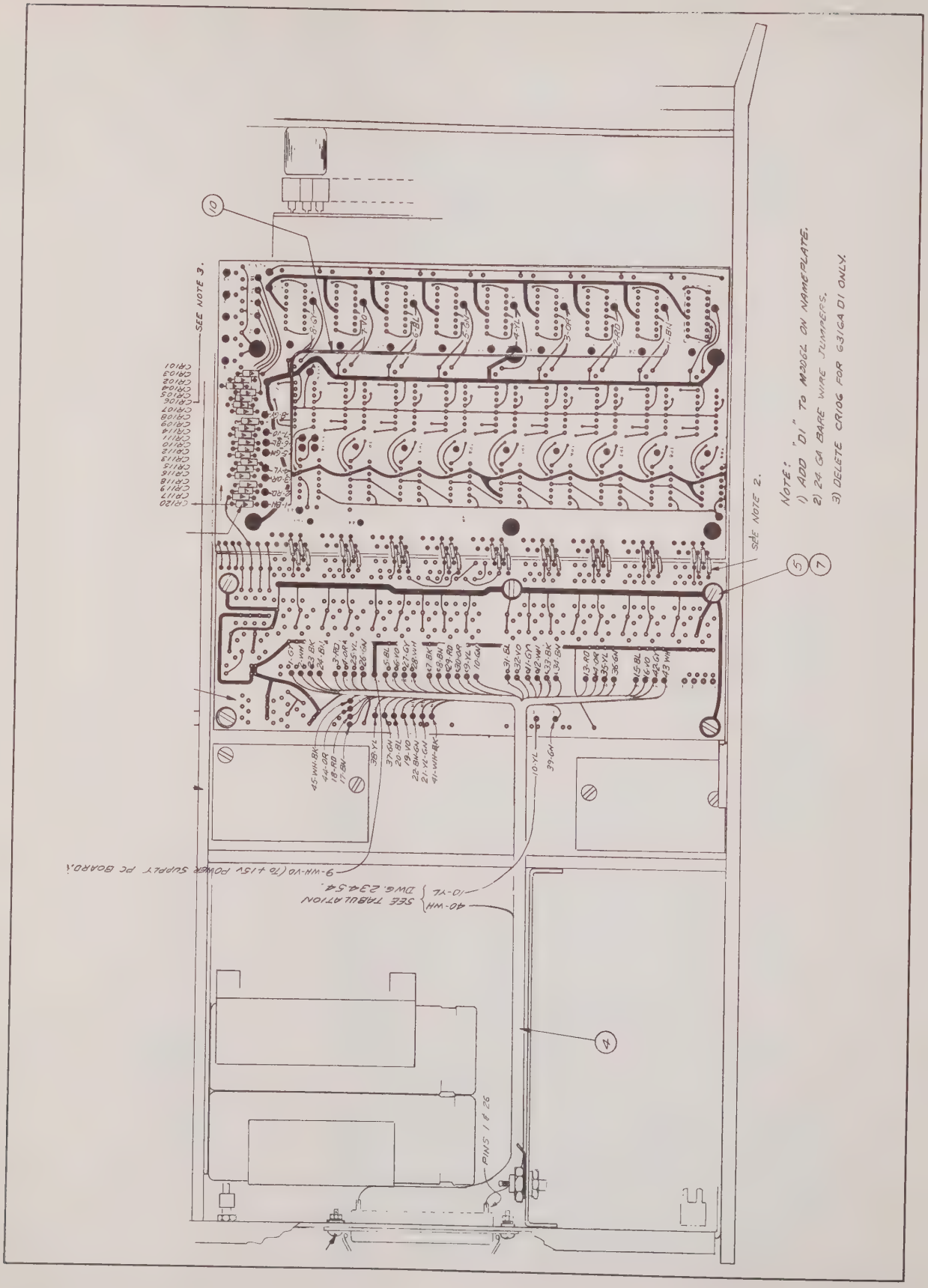

NOTE:
1) ADD "D1" TO MODEL ON NAMEPLATE.
2) 24 GA BARE WIRE JUMPERS.
3) DELETE CR10G FOR 631GA D1 ONLY.
SEE NOTE 2.
SEE NOTE 3.
9-WH-VO (To +15V POWER SUPPLY PC BOARD).
40-WH
10-YL
SEE TABULATION DWG. 23454.
PINS 1 & 26

Figure 7-18. D1 Option Final Assembly (23893)

D1 Option P.C. Board Assembly Parts List

Ref.	Description	SD Part No.	Manufacturers Part No.
	Schematic	23454	
CR1 Thru CR8	Diode, IN4151	CR0150	
	Same as CR1		
Q1 Thru Q39	Transistor, 2N3565	Q0237	
	Same as Q1		
R1 Thru R46	Resistor, 15k, 1/4W, 5%	R0728	
	Same as R1		
R51 Thru R86	Resistor, 15k, 1/4W, 5%	R0728	
	Same as R51		
R90	Resistor, 5.6k, 1/4W, 5%	R0821	
R87	Resistor, 300Ω, 1/4W, 5%	R0670	
R88	Resistor, 1k, 1/4W, 5%	R0765	
R89	Resistor, 300Ω, 1/4W, 5%	R0670	
R91	Resistor, 15k, 1/4W, 5%	R0728	

D1 Option Final Assembly Parts List

Ref.	Description	SD Part No.	Manufacturers Part No.
CR101 Thru CR120	Diode, IN4454	CR0335	
	Same as CR101		
	Connector, 50 Pin/W Hood	J0171	

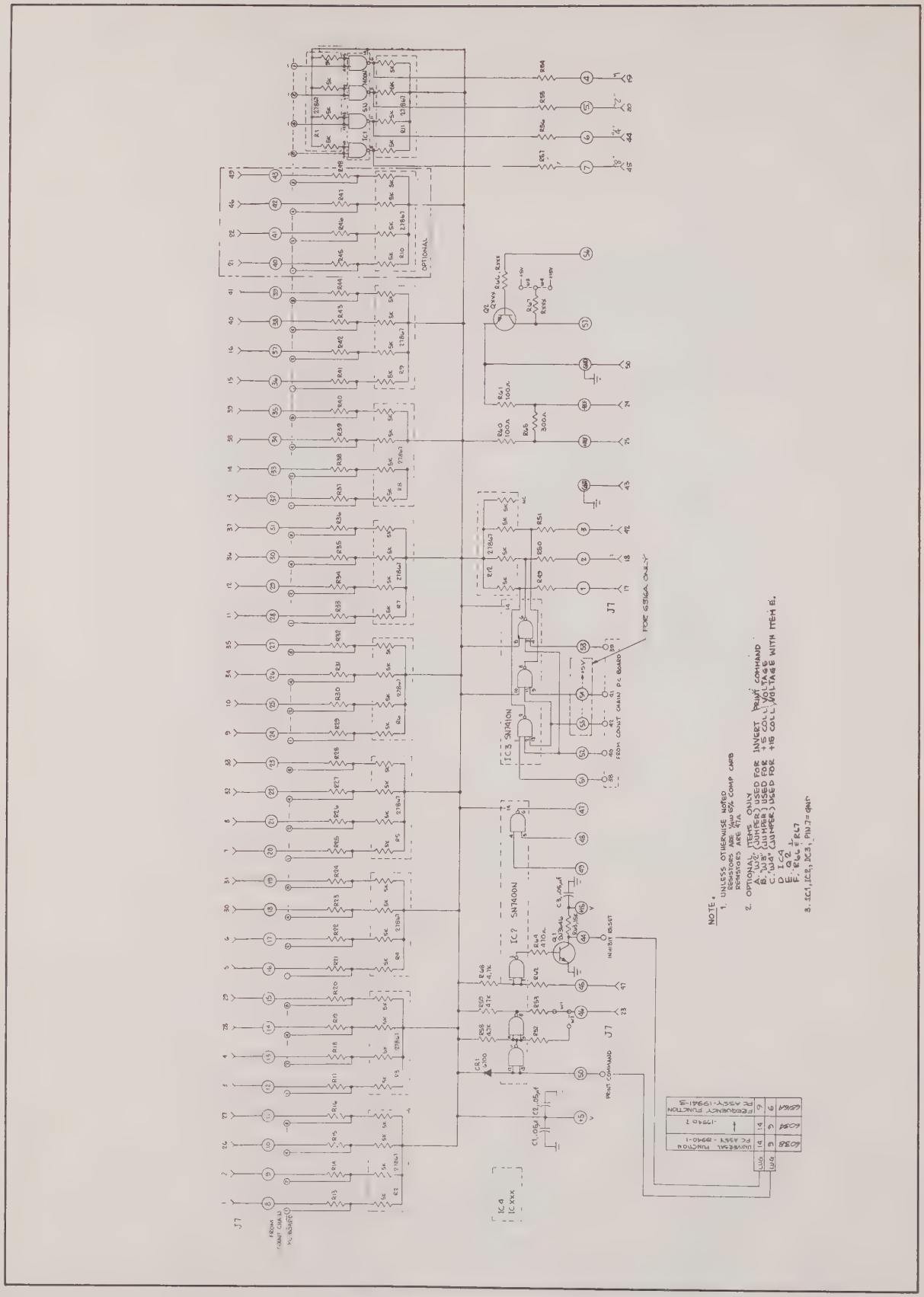

NOTE:
1. UNLESS OTHERWISE NOTED
RESISTORS ARE 1/4W 5% COMP CMPS
RESISTORS ARE R1-R64
2. OPTIONAL ITEMS ONLY
A. W3 (JUMPER) USED FOR INVERT PRINT COMMAND
B. W4 (JUMPER) USED FOR +5 COIL VOLTAGE
C. W5 (JUMPER) USED FOR +15 COIL VOLTAGE WITH ITEM E.
D. Q2
E. IC4
F. R66 & R67
3. IC1, IC2, IC3, PIN 7=GND
FOR GSI6A ONLY
FROM COUNT CHAN PC BOARD
PRINT COMMAND
INHIBIT RESET
OPTIONAL
UNIVERSAL FUNCTION PC A35KV - 19940-1
FREQUENCY FUNCTION PC A35KV-19941-3

Figure 7-19. D3 Option Schematic (S29436)

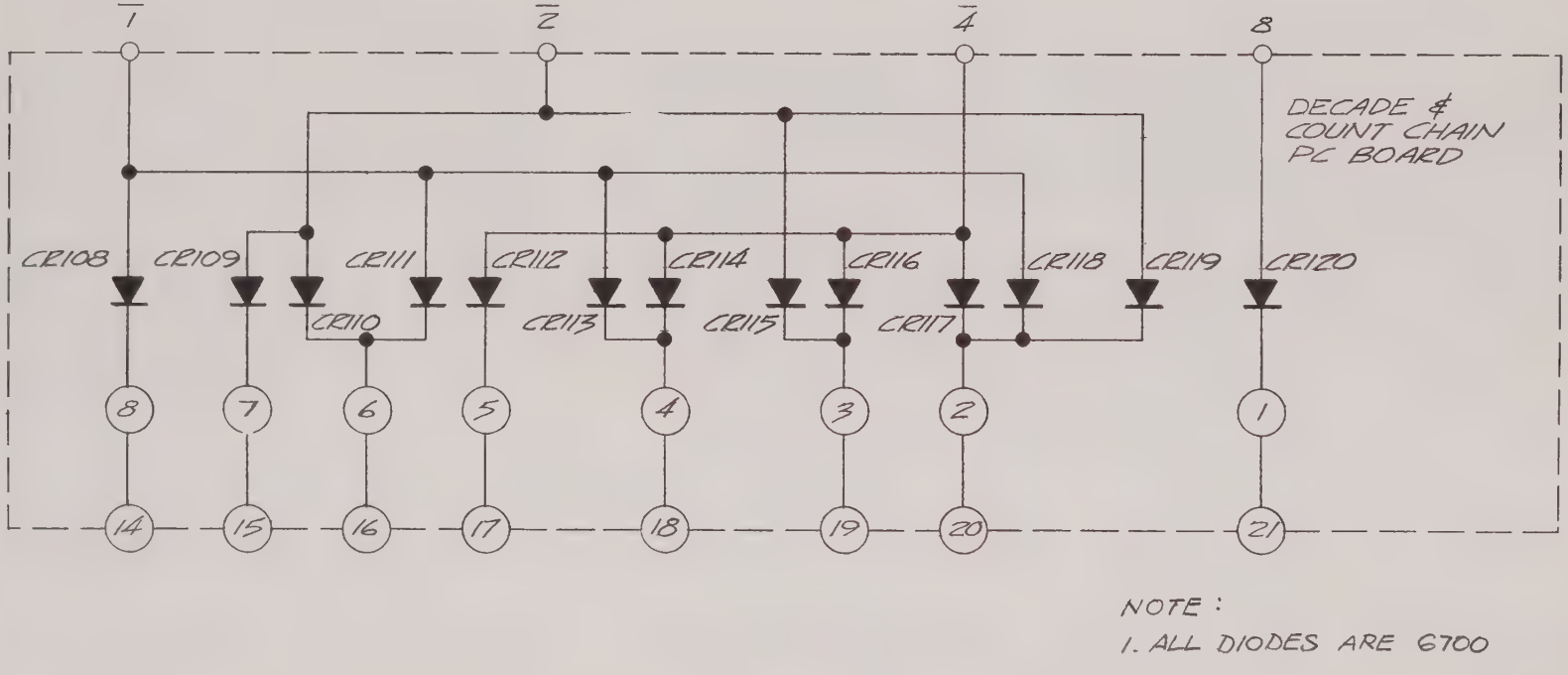


Figure 4-20. D3 Decoding Diodes (S29592)

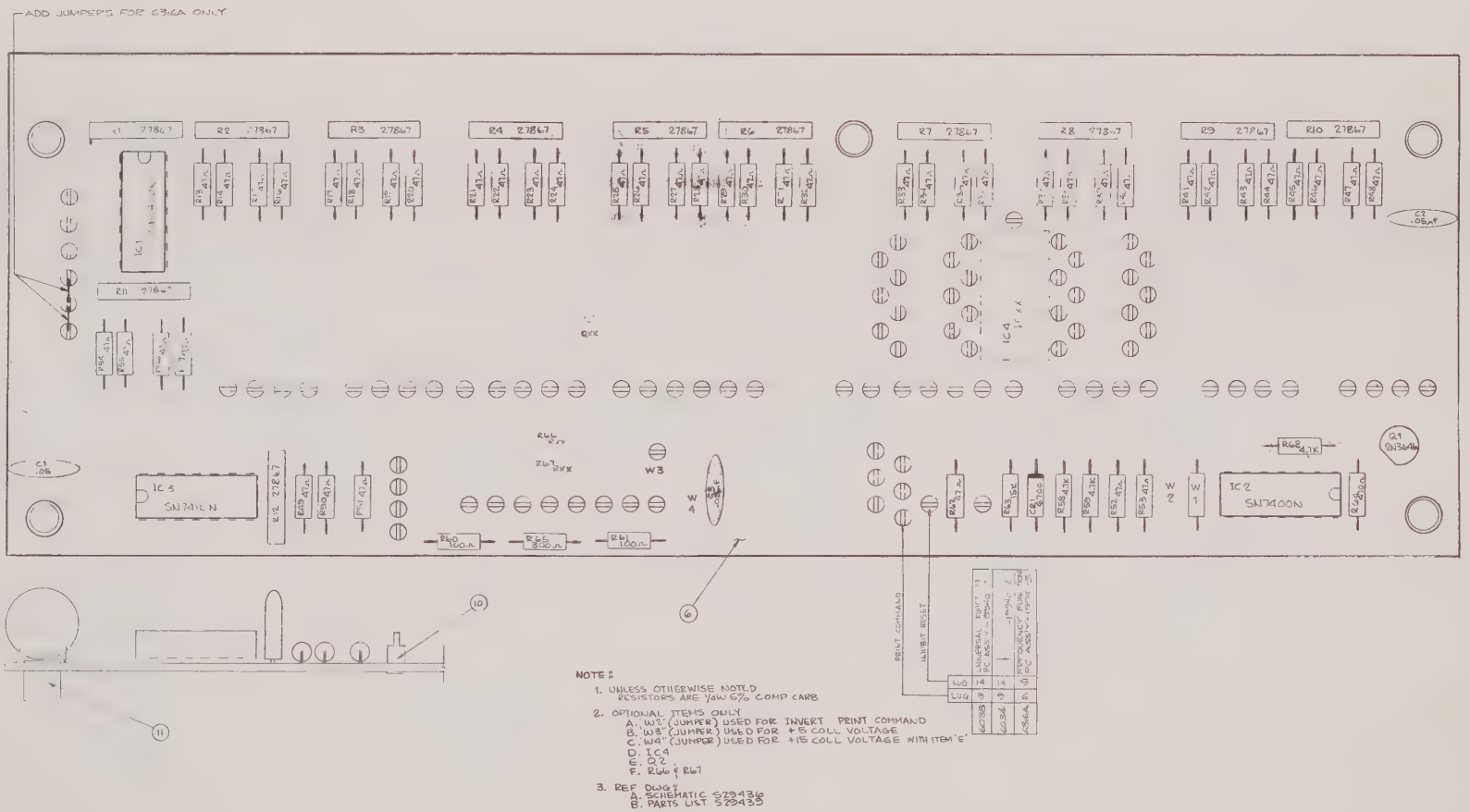


Figure 7-21. D3 Option P.C. Assembly (S29439)

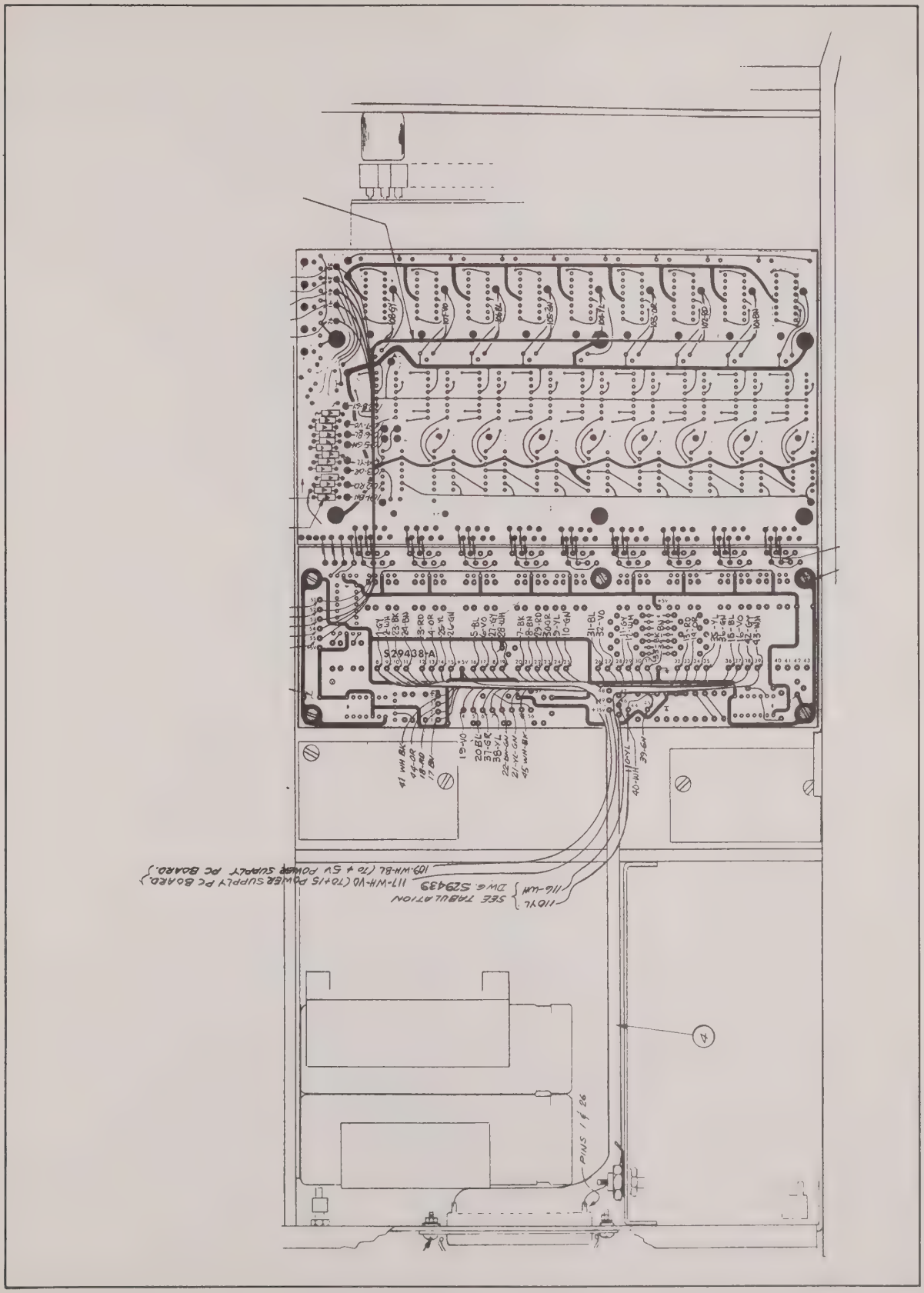


Figure 7-22. D3 Option Final Assembly (S29444)

D3 Option P.C. Board Assembly Parts List

Ref.	Description	SD Part No..	Manufacturers Part No.
	Schematic	S29436	
CR1	Diode, 6700	6700	
IC1	Integrated Circuit, SN4700N	19705	
IC2	Integrated Circuit, SN4700N	19705	
Q1	Transistor, 2N3646	Q0218	
Q2	Qxx		
R1 Thru	Resistor, 27867	27867	
R12	Same as R1		
R13 Thru	Resistor, 47Ω, 1/4W, 5%, cc	R0743	
R57	Same as R13		
R58	Resistor, 4.7k, 1/4W, 5%, cc	R0892	
R59	Resistor, 4.7k, 1/4W, 5%, cc	R0892	
R60	Resistor, 100Ω, 1/4W, 5%, cc	R0966	
R61	Resistor, 100Ω, 1/4W, 5%, cc	R0966	
R62	Resistor, 47Ω, 1/4W, 5%, cc	R0743	
R63	Resistor, 15k, 1/4W, 5%, cc	R0728	
R64	Resistor, 470Ω, 1/4W, 5%, cc	R1044	
R65	Resistor, 300Ω, 1/4W, 5%, cc	R0670	
R66	Rxx		
R67	Rxx		
R68	Resistor, 4.7k, 1/4W, 5%, cc	R0892	
C1 Thru	Capacitor, .05μF, 50V	C0708	
C3	Same as C1		

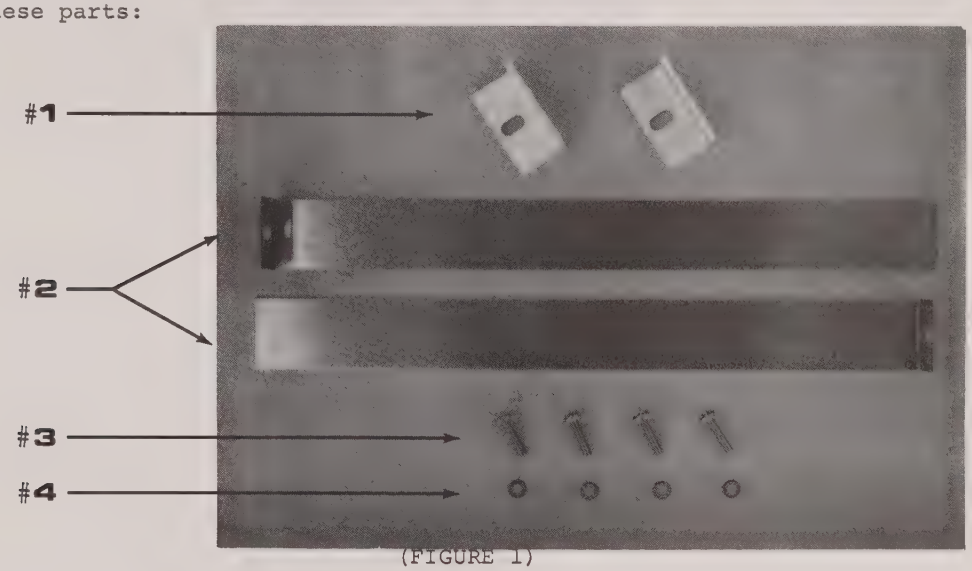
D3 Final Assembly Parts List

Ref.	Description	SD Part No.	Manufacturers Part No.
CR108 Thru	Diode, 6700	6700	
CR120	Same as CR108		
	Connector, 50 Pin/W Hood	J0171	

ADDENDUM

THIN LINE RACK MOUNTING KIT

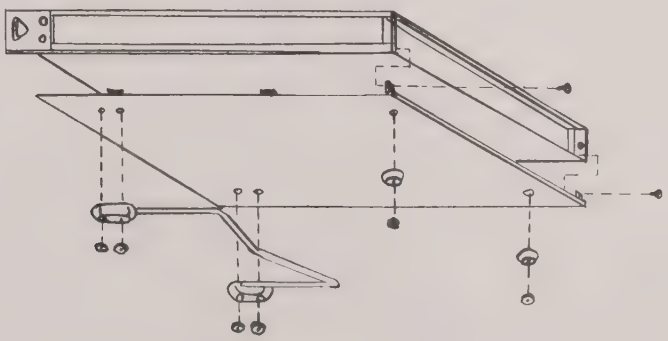
A kit of loose parts, needed to rack mount this instrument, has been included in the shipping container. Do not discard the container or any packing materials until this kit has been located and its contents verified. The following list may be used to inventory these parts:



(FIGURE 1)

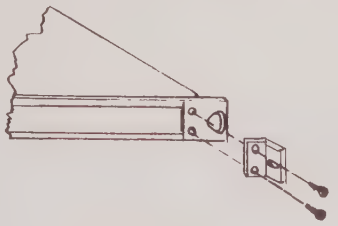
___	2 each Rack Mounting Brackets	Item #1
___	2 each Rack Mounting Adapters	Item #2
___	4 each 8-32 x 3/4" Screws	Item #3
___	4 each #8 Internal Tooth Lockwashers	Item #4

Prepare the instrument for rack mounting as follows:



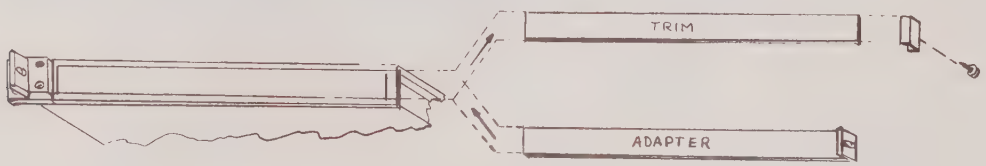
(FIGURE 2)

1. Remove the bottom cover by first removing the 2 hold-down screws on the rear panel, then sliding the cover toward the rear to disengage the hold-down tabs. Lift the cover free.
2. Remove the tilt stand and bumper feet, and store for possible reinstallation later.
3. Replace the bottom cover by reversing the steps in "1" above.



(FIGURE 3)

4. Remove the two screws securing each of the front handles. Do NOT remove the handles.
5. Install the Rack Mounting Brackets (Item #1) over the handles as shown, and secure them with the 3/4" screws and lockwashers provided.
6. Remove the rear edge trim moldings for the side trim panels, and slide the trim panels out. Store both items for possible reinstallation later.



(FIGURE 4)

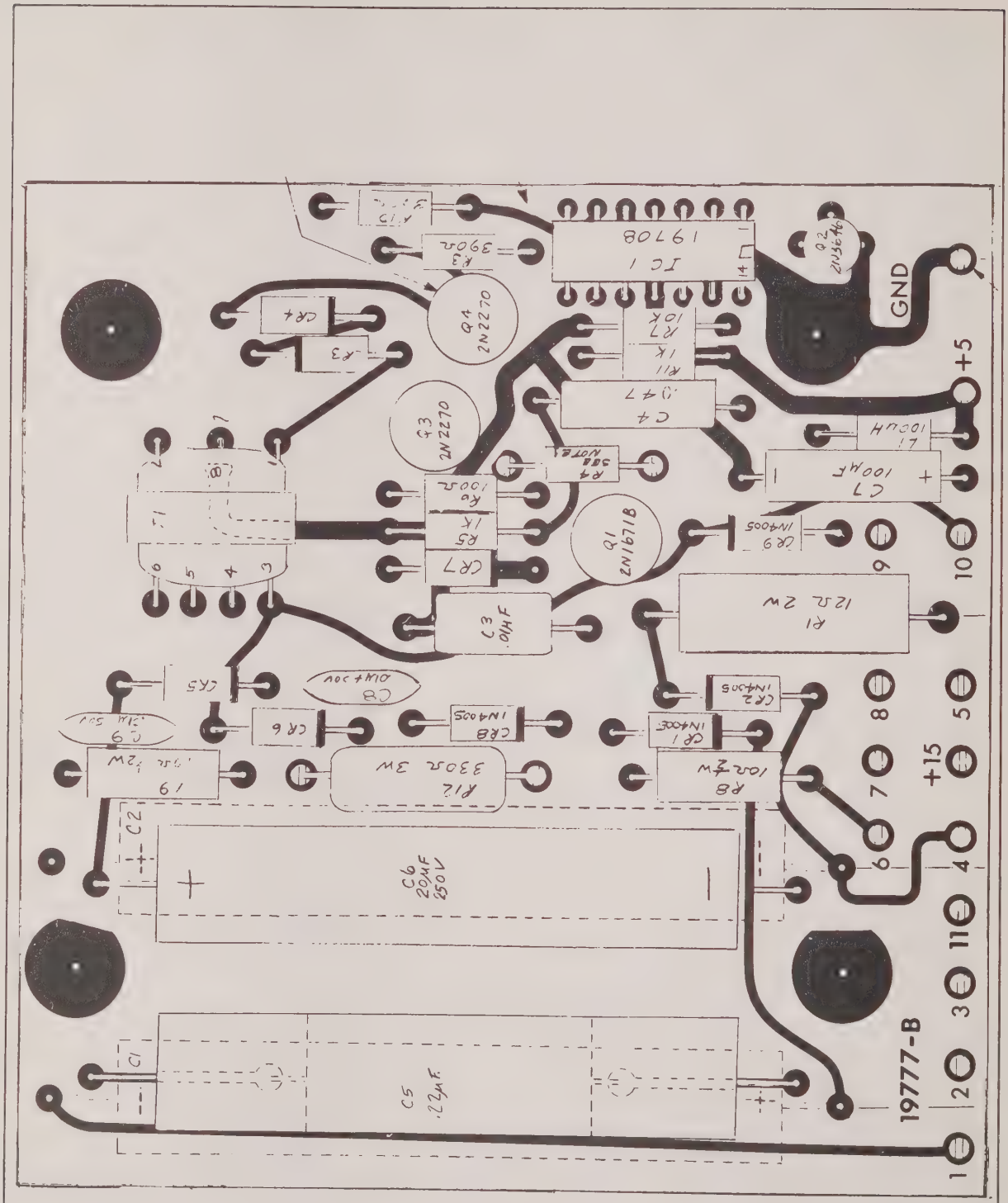
7. Slide the Rack Mounting Adapters into the spaces vacated by the side trim panels, pointed out flages to the rear and as shown.

L2 OPTION
(6000 SERIES)

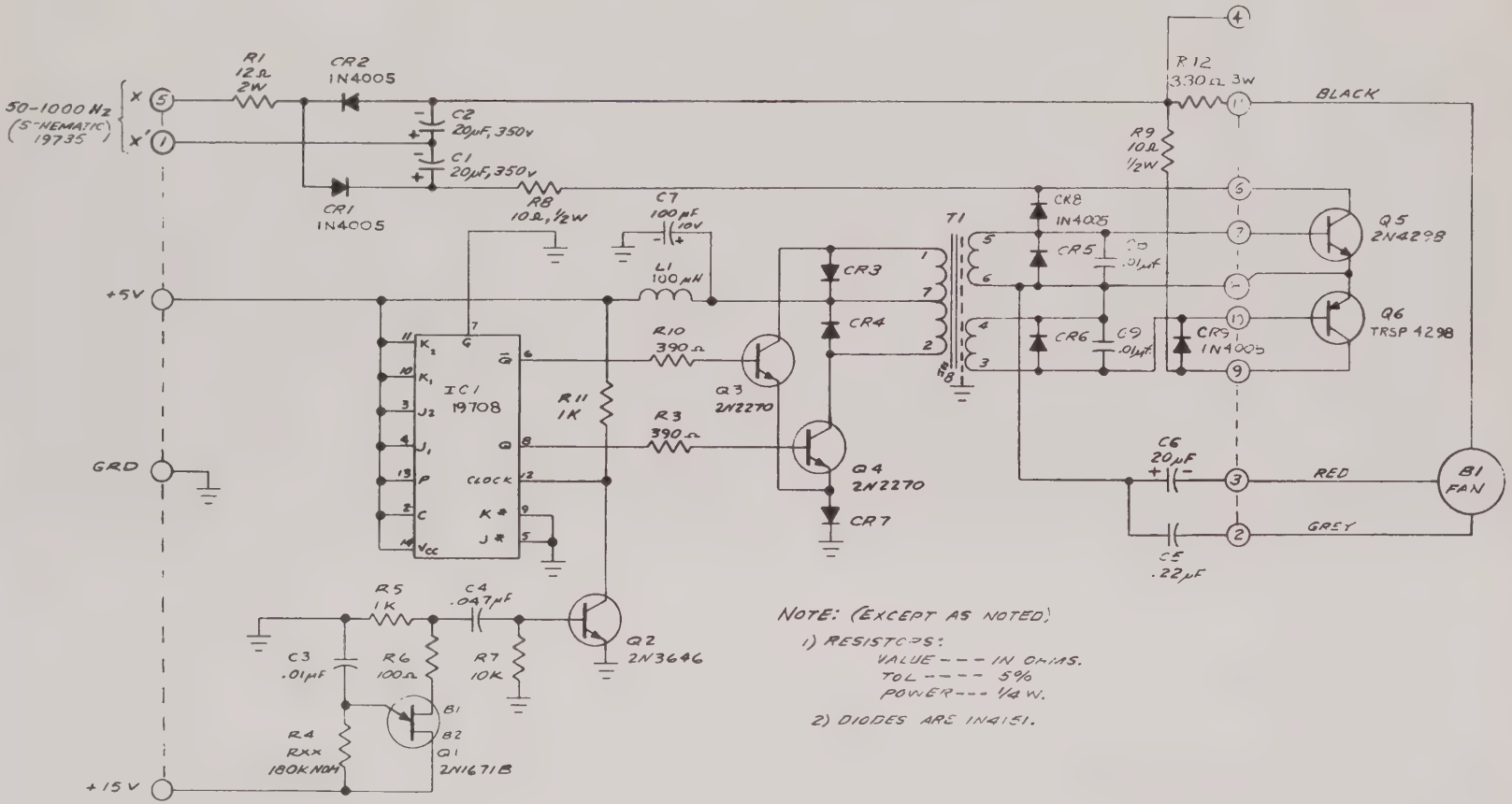
This option makes the instrument capable of operating from 50-1000 Hz power sources.

The following drawings are part of this option:

	Assembly	Schematic
Fan Driver P.C. Assembly	D19778C	C23348C
L2 Option Final Assembly	C27359C	



FAN DRIVER P.C. ASSEMBLY D19778C



NOTE: (EXCEPT AS NOTED)

1) RESISTORS:
VALUE --- IN OHMS.
TOL ---- 5%
POWER --- ¼ W.

2) DIODES ARE IN4151.

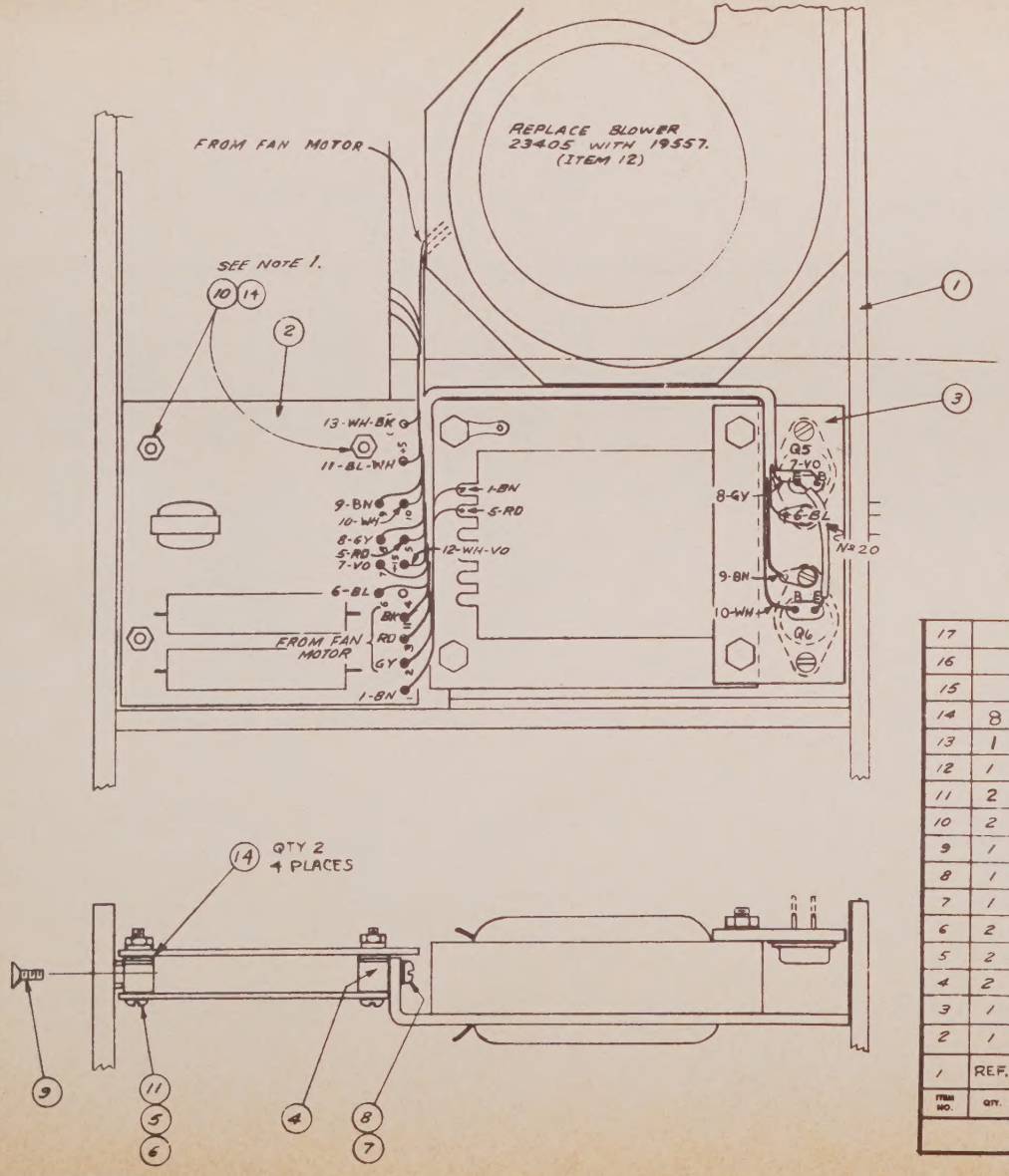
FAN DRIVER P.C. ASSEMBLY SCHEMATIC C23348C

FAN DRIVER P.C. ASSEMBLY PARTS LIST

Ref.	Description	SD Part No.
	Fan Driver P.C. Assembly	D19778C
	Fan Driver P.C. Assembly Schematic	C23348C
C1	Capacitor, 20µf, 350V	C1094
C2	Capacitor, 20µf, 350V	C1094
C3	Capacitor, .01µf, Mylar	C0852
C4	Capacitor, .047µf, Mylar	C0700
C5	Capacitor, .22µf, Metalized	C0565
C6	Capacitor, 20µf, 250V	C1093
C7	Capacitor, 100µf, 10V, Tant	C0369
C8	Capacitor, .01µf, 50V	C0562
C9	Capacitor, .01µf, 50V	C0562
CR1	Diode, IN4005	CR0284
CR2	Diode, IN4005	CR0284
CR3	Diode, IN4151	CR0150
CR4	Diode, IN4151	CR0150
CR5	Diode, IN4151	CR0150
CR6	Diode, IN4151	CR0150
CR7	Diode, IN4151	CR0150
CR8	Diode, IN4005	CR0284
CR9	Diode, IN4005	CR0284
IC1	Integrated Circuit	19708
L1	Inductor, 100µH	L0073
Q1	Transistor, 2N1671B	Q0884
Q2	Transistor, 2N3646	Q0218
Q3	Transistor, 2N2270	Q0102
Q4	Transistor, 2N2270	Q0102
R1	Resistor, 12Ω, 2W, 5%	R2297
R2	Not Used	
R3	Resistor, 390Ω, 1/4W, 5%	R0880
R4	Resistor, 180k, 1/4W, 5%	R1042
R5	Resistor, 1k, 1/4W, 5%	R0765
R6	Resistor, 100Ω, 1/4W, 5%	R0966
R7	Resistor, 10k, 1/4W, 5%	R0766
R8	Resistor, 10Ω, 1/2W, 5%	R1084
R9	Resistor, 10Ω, 1/2W, 5%	R1084

FAN DRIVER P.C. ASSEMBLY PARTS LIST (Con't.)

Ref.	Description	SD Part No.
R10	Resistor, 390Ω, 1/4W, 5%	R0880
R11	Resistor, 1k, 1/4W, 5%	R0765
R12	Resistor, 330Ω, 3W	02413300
T1	Transformer	19803



ITEM NO.	QTY.	PART NUMBER	DESCRIPTION	SCHEMATIC REF. NO.
17				
16				
15				
14	8	H 0226	FIBRE WASHER	
13	1	27360	WIRE LIST	
12	1	19557	FAN MOTOR	
11	2	H-0286	SCREW, 4-40 x 5/8 PHMS	
10	2	H-0819	SCREW, 4-40 x 3/4 PHMS	
9	1	H-0430	SCREW, 6-32 x 1/8 FHMS	
8	1	H-0986	SCREW, 6-32 x 1/4 PHMS	
7	1	H-0410	WASHER, No 6 SHAKE	
6	2	H-0249	NUT, 4-40, SMALL	
5	2	H-1282	WASHER, No 4 SHAKE	
4	2	19983	BLOCK, FAN DRIVER BOARD MOUNTING	
3	1	27349	PLATE, TRANSISTOR MTG. ASSEMBLY	
2	1	19773	FAN DRIVER PC ASSEMBLY	
1	REF.	~	6000 SERIES INSTRUMENT	

LIST OF MATERIALS

L2 OPTION FINAL ASSEMBLY C27359C

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